Consultation Paper No. 22/ 2023

भारतीय दूरसंचार विनियामक प्राधिकरण

Telecom Regulatory Authority of India

Consultation Paper on Assignment of Spectrum in E&V Bands, and Spectrum for Microwave Access (MWA) & Microwave Backbone (MWB)

New Delhi, India

27th September, 2023

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New Delhi- 110002

Written Comments on the Consultation Paper are invited from the stakeholders by 25th October 2023 and counter-comments by 8th November 2023. Comments and counter-comments will be posted on TRAI's website www.trai.gov.in. Comments and counter-comments may be sent, preferably in electronic form, to Shri Akhilesh Kumar Trivedi, Advisor (Networks, Spectrum and Licensing), TRAI on the email ID advmn@trai.gov.in.

For any clarification/ information, Shri Akhilesh Kumar Trivedi, Advisor (Networks, Spectrum and Licensing), TRAI may be contacted on Telephone No. +91-11-23210481.

Note: In this paper, LSA refers to Telecom Circle/ Metro service area as defined for Access Service Authorization under the Unified License.

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CHAPTER I: INTRODUCTION

A. DoT's Reference to TRAI

1.1 Through the letter No. L-14035/10/2022-BWA dated 12.08.2022 (**Annexure-1.1**), the Department of Telecommunications (DoT) sent a Reference under the Section 11(1) (a) of the TRAI Act, 1997 (as amended) on the subject- 'Seeking TRAI recommendations for assignment of E&V Bands; and Microwave Access (MWA) & Microwave Backbone (MWB) spectrum in existing frequency bands of 6/7/13/15/18/21 GHz' to Telecom Regulatory Authority of India (hereinafter, also referred to as "TRAI", or "the Authority"). An extract of the afore mentioned letter dated 12.08.2022 is reproduced below:

"TRAI had provided its recommendations dated 29.08.2014 on "Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers". In these recommendations, TRAI had also provided recommendations on allocation and pricing methodology for E band (71-76/ 81-86 GHz) and V bands (57-64 GHz) spectrum. Subsequent to DoT's back reference dated 16.10.2015, TRAI's response/ letters dated 17.11.2015, 06.05.2016 and 15.07.2016 were also received by DoT.

2. The matter of E and V band spectrum assignment was deliberated in DoT, and it emerged that while the spectrum in E and V bands should be assigned through auction for provisioning of commercial telecom services; there may be certain non-TSP/ non-commercial usages like captive/ individual point to point/ multipoint usages, which also need spectrum in these bands and where auction may not be feasible.

2.1 In V band, the device/ chipset eco-system supporting various technologies for data transfer between consumer's devices such as smartphones, camera, laptops etc. has developed. The technologies used for such devices are designed for short-range, indoor, interference-tolerant applications. Therefore, while the V band spectrum can be assigned through auction for establishment of indoor/ outdoor telecom networks, allowing low

power, indoor usages of V band on license-exempt basis for consumer device-to-consumer device data transfer may go a long way in serving greater public interest and realizing significant socio-economic gains.

3. With regard to assignments of MWA & MWB spectrum in frequency bands 6/7/13/15/18/21 GHz to TSPs, it has been decided to seek a fresh recommendation of TRAI on allocation methodology, quantum and pricing of MWA and MWB RF carriers, in view of technological changes which have taken place over the years as well as considering the existing assignments to TSPs.

4. In view of the above, TRAI is requested to provide its recommendations under the terms of clause 11(1) (a) of TRAI Act, 1997 as amended by TRAI Amendment Act 2000 on the following:

(a) applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/ usages, spectrum cap, payment terms, eligibility conditions, methodology of auction and other associated conditions for auction of E band spectrum for establishment of terrestrial and/ or satellite-based telecom networks.

(b) applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/usages, spectrum cap, payment terms, eligibility conditions methodology of auction and other associated conditions for auction of V band spectrum for establishment of terrestrial and/ or satellite-based telecom networks.

(c) quantum of spectrum to be earmarked for non-commercial/ captive/isolated use in E and V bands; and methodology of assignment, where auction is not feasible, and pricing for the same.

(d) feasibility, including technical parameters, for allowing low power, indoor, consumer device-to-consumer device usages on license-exempt basis, in parallel to use of the auction acquired spectrum by telecom service providers for establishment of terrestrial and/ or satellite-based telecom networks, in part or full V band.

(e) a fresh recommendation on allocation methodology, quantum and pricing of MWA and MWB RF carriers in 6/7/ 13/15/18/21 GHz bands, for establishment of terrestrial and/ or satellite-based telecom networks as well as for non-commercial/ captive/ isolated use.

(f) provide any other recommendations deemed fit for the purpose mentioned under (a) to (e) above in these frequency bands, including the regulatory/technical requirements as enunciated in the relevant provisions of the latest ITU-R Radio Regulations."

1.2 In this regard, TRAI, through a letter dated 09.09.2022, sought some additional information/ clarifications from DoT. In response, through a letter dated 11.10.2022 and email dated 16.11.2022, DoT provided the requisite information/ clarifications to TRAI. Some of the key information/ clarifications sought by TRAI and the response received from DoT are mentioned below:

(a) Considering that DoT in its reference letter dated 12.08.2022 had mentioned, *inter-alia*, that "*it has been decided to seek a fresh recommendation of TRAI on allocation methodology, quantum and pricing of MWA and MWB RF carriers, in view of the technological changes which have taken place over the years as well as considering the existing assignments to TSPs",* TRAI requested DoT to provide a detailed note elaborating the rationale (technological changes referred by DoT and its relationship with the existing assignments) for seeking fresh recommendations from TRAI. In this regard, DoT provided the following inputs:

"It may be mentioned that since the recommendations on MWA/ MWB dated 29-08-2014, two WRCs had held in between and WRC-19 has adopted many bands for IMT e.g. 26 GHz, 28 GHz, 38 GHz & 42 GHz, which were part of 2014 recommendations for backhaul purposes. Among others, the band 26/ 28 GHz, 38 GHz, 47 GHz, 66 GHz to 71 GHz have been identified/ adopted for IMT. Further, 3GPP has identified 52.6 GHz to 71 GHz for 5G NR (New Radio). The 3GPP have also adopted use

of spectrum bands as IAB (Integrated Access Backhaul). Also, Study has begun at ITU under agenda item 9.1(c) for use of Fixed service spectrum band (that includes Backhaul bands also) for use in IMT System for providing fixed broadband services. Considering these developments, TRAI's recommendations of 2014 and 2015 in the matter are required to be revisited by TRAI."

(b) Considering that DoT in its letter dated 12.08.2022, had stated, *inter-alia*, that *"[t]he matter of E and V band spectrum assignment was deliberated in DoT, and it emerged that while the spectrum in E and V bands should be assigned through auction for provisioning of commercial telecom services"*, TRAI requested DoT to provide, *inter-alia*, the following information/ clarifications:

i. A detailed note elaborating the rationale for arriving at the conclusion that the spectrum in E & V bands should be assigned through auction for provisioning of commercial telecom services.

ii. Global practices where E & V bands have been assigned through auction, which were considered by DoT.

iii. Status of TRAI's recommendations of 2014 on pricing for link-to-link assignment of E & V bands.

In response, DoT provided the following inputs:

"TRAI may recall its letter dated 08.07.2015, wherein, it was stated that "It is for DoT to take a policy decision as to whether it is legally tenable to allocate spectrum by any other mechanism (viz, administrative) than auction in consultation with the Ministry of Law." Subsequently, opinion of Ministry of Law & Justice (MoLJ) as well as opinion of Ld. AG was sought. The Ld. AG, among others, opined at para 7 that in cases where there are competitors who are prepared to bid for the limited spectrum which is available, be considered through auction so that the Government would be able to earn revenue from such competitive bidding, among others. In this regard, many TSPs / ISPs have demanded

for auction of E & V band from time to time. This view of TSPs has also been endorsed by the TRAI in its recent recommendations dated 11.04.2022 at para 2.405 to 2.411 and noted finally at para 2.411 that DoT may appropriately examine the issue raised by stakeholders.

Regarding V band spectrum, some countries had delicensed it during 2010 to 2014, when there was no visibility on the use of this spectrum for 5G/ IMT and also the alternate telecommunications technologies like Wi-Fi have evolved to make it an equivalent technology to 4G/ 5G. Further, during last 7-8 years, technologies have developed which compete with 4G/ 5G/ IMT. Therefore, hardly any country has delicensed V-band post TRAI's recommendations in 2014-2015 as 5G & equivalent technologies have been developed in these bands. Further, these bands may also play key role in 6G technology.

The recent 3GPP Release -17 dated 12th December 2020 envisage use of 52.6-71 GHz (which include V-band- 57-64 GHz under consideration in India) for 5G terrestrial networks. It also uses this band for Integrated Access and Backbone (IAB).

Further, regarding the recommendations for assignments of these bands on link-to-link basis, DoT is of the view that the large reusability /small link size, dense deployment, makes E & V bands more suitable for LSA wise assignments rather than link-by-link assignment as the accounting/ Administration of large number of links in these bands and charging therein is not feasible in Indian context. In the past due to similar complexity of link-by-link assignment, the link-based charging for MWA/ MWB was discontinued during early 2000 and LSA based assignments/ charging was adopted.

As both of E & V band are to be assigned on LSA/ pan India basis, hence, auction of these spectrum bands on LSA basis is feasible and therefore, such spectrum may be assigned through competitive bidding/ auction in accordance with opinion of Ld. AG.

The Audit has also recommended, among others, that DoT may take an early decision in consultations with TRAI on allotment/ assignment of spectrum for in E-band (71-76/ 81-86 GHz) and V-band (57-64 GHz) for providing support to mobile communications, ISP service providers and effective roll out of 5G services through market related process wherever feasible/ viable.

Accordingly, after a detailed deliberation, Government has decided to seek recommendations for assignment of E&V bands through auction for provisioning of commercial telecom services band per the reference dated 12.08.2022."

(c) Considering that DoT in its letter dated 12.08.2022, had also sought TRAI's recommendations on *"quantum of spectrum to be earmarked for non-commercial/ captive/ isolated use in E & V bands; and methodology of assignment where auction is not feasible and pricing for the same",* TRAI requested DoT to clarify, *inter-alia*, as to what type of use (Access/ Backhaul, indoors/ outdoors, etc.) of E & V bands is being envisaged for non-commercial/ captive/ isolated use and details of the demand for spectrum in E & V bands for non-commercial/ captive/ isolated use received by DoT. In response, DoT provided the following inputs:

"(a) It is envisaged to use E & V band for non-TSP/ non-commercial usages to the entities for their captive/ individual point-to-point/ multipoint usages/ requirements in isolated manner without any connectivity to public networks in line with isolated/ captive requirements in the part in MW bands. TRAI is requested to assess the demand of such captive usages through consultation process.

(b) No such assignments have been made so far.

(c) No such demand has been received so far."

1.3 With respect to the DoT's view on E & V bands, as conveyed through the letter dated 11.10.2022, and as indicated in Para 1.3 (b) above that *'[t]his view of TSPs has also been endorsed by the TRAI in its recent recommendations dated*

11.04.2022 at para 2.405 to 2.411 and noted finally at para 2.411 that DoT may appropriately examine the issue raised by stakeholders', it may be noted that TRAI in its recommendations on 'Auction of Spectrum in frequency band identified for IMT/5G' dated 11.04.2022 at para 2.405 to 2.408 discussed the need for high capacity backhaul bands and also referred to the TRAI's earlier recommendations on 'Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carrier' dated 29.08.2014. TRAI's recommendations of 29.08.2014, *inter-alia*, included recommendations for opening up of High capacity backhaul E-band (71-76/ 81-86 GHz) and V-band (57-64 GHz), which were still under consideration by DoT. The comments received from the stakeholders were summarized under para 2.409 and 2.410 of the TRAI recommendations dated 11.04.2022 and in para 2.411, it was mentioned that *"the Authority is of the view that DoT may appropriately examine the issue raised by the stakeholders."* Clearly, TRAI did not endorse the views of the stakeholders on the subject.

B. The Present Consultation Paper

1.4 In this background, this consultation paper is being issued for soliciting comments of stakeholders on the issues related to the 'Consultation Paper on Assignment of Spectrum in E-band, V-band, and Microwave Access (MWA)/ Microwave Backbone (MWB) Spectrum in Existing Frequency Bands'. This chapter provides background information on the reference received from the DoT. **Chapter II** deals with the issues relating to the assignment of spectrum for MWA and MWB. **Chapter III** deals with the issues relating to the assignment of spectrum in E-band and V-band. **Chapter IV** deals with valuation and pricing of spectrum in E-band, V-band, MWA and MWB, and **Chapter V** summarizes the issues for consultation.

CHAPTER II: ISSUES RELATED TO ASSIGNMENT OF SPECTRUM FOR MWA AND MWB

A. Background

2.1 ITU in its 'Vocabulary of terms for wireless access'[1], defined the backhaul communication as 'transport of aggregate communication signals from base stations to the core network'.

2.2 A typical mobile network consists of an access network, backhaul and core network. Access network is that part of the network, through which, subscribers access the telecom network services. Access network provides last-mile connectivity, which could be either wired or wireless. Core network is the central element of a mobile network that provides services to subscribers who are connected by the access network. Backhaul network is used to transfer the traffic from/ to the access network to/ from the core network or other nodes of the network.

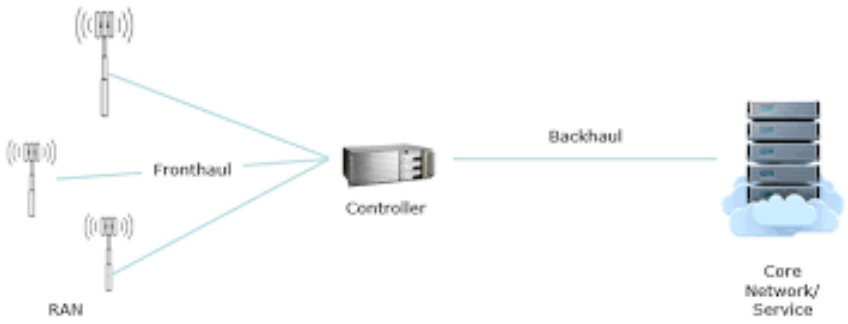

Figure 2.1: Typical mobile network

2.3 For backhauling of telecommunication traffic, wired or wireless media could be used. Traditionally, copper wires were used for backhaul networks. However, with the increase in traffic, optical fibre cable (OFC) is, at present, the most desired medium as it practically offers infinite capacity. However, laying OFC could be very difficult in some places such as tough terrains, hilly regions, water

[1] https://www.itu.int/dms_pubrec/itu-r/rec/f/R-REC-F.1399-1-200105-I!!PDF-E.pdf

bodies, etc. Further, in places that are sparsely populated and where telecom traffic is not substantial, laying OFC may not be an economically viable option. Besides, at some places, there may be difficulties in getting permissions for laying OFC, and/ or Right of Way (RoW) charges for laying OFC could be a matter of concern. As a result, telecom service providers may prefer to deploy wireless backhaul in places, where laying OFC is either difficult and/ or economically unviable.

2.4 For wireless backhaul, telecom service providers make use of microwave technology. Microwave is a 'line-of-sight' wireless communication technology that uses high frequency beams of radio waves to provide high speed wireless connections that can send and receive voice, video, and data information.

2.5 In mobile communication networks, microwave technology is widely deployed to provide point-to-point (P2P) radio frequency links in mobile backhaul as well as in the backbone network. The mobile backhaul refers to the transport network that connects the core network and the Radio Access Network (RAN) of the mobile communication network. The introduction of small cells has given rise to the concept of 'front haul', which is a transport network that connects the macrocell to the small cells. Whilst mobile backhaul and fronthaul are different concepts, the term mobile backhaul is generally used to encompass both concepts[2]. The backbone network is used to interconnect different nodes situated at different geographical locations.

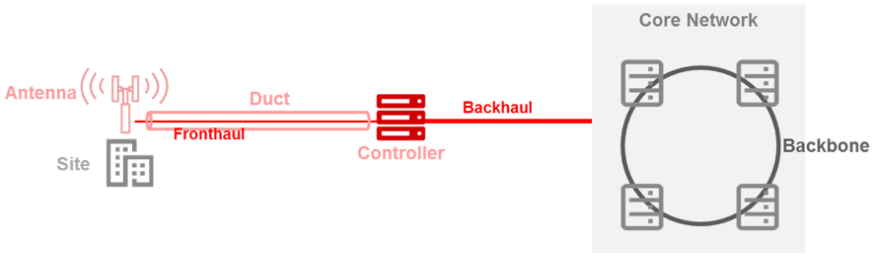

Figure 2.2: Mobile network and the scope of mobile backhaul, Source: GSMA

[2] https://www.gsma.com/futurenetworks/wiki/mobile-backhaul-an-overview/

2.6 For the establishment of backhaul P2P links, microwave frequencies in traditional microwave bands (6, 7, 13, 15, 18, and 21 GHz) are used. In these bands, microwave frequencies are generally assigned in blocks of 2x28 MHz, known as microwave carriers. There are two types of microwave carriers viz. Microwave Access (MWA) Carriers and Microwave Backbone (MWB) Carriers.

2.7 MWA carriers are generally in frequency bands of 10 GHz and beyond. These are assigned for short-haul systems which are used to carry traffic through relatively shorter distances. MWA carriers are typically used mainly in the pre-aggregation part of mobile backhaul networks. In India, currently, 13 GHz (12.75-13.25 GHz), 15 GHz (14.5-15.5 GHz), 18 GHz (17.7-19.7 GHz,) and 21 GHz (21.2-23.6 GHz) bands are used for the assignment of frequencies for MWA carriers[3]. On the other hand, MWB carriers are assigned for relatively longer links. In India, currently, 6 GHz and 7 GHz bands are used for the assignment of frequencies for MWB P2P links.

2.8 Both MWA and MWB are used to connect the network nodes for backhauling the traffic generated by the access network. With the changing requirement due to technological advancements and development of high data applications, higher bands have also been opened up globally to meet the growing traffic backhauling requirement. With the implementation of 5G technology, there may be a requirement for significant increase in wireless backhaul capacity which necessitates for wider bandwidth solutions.

2.9 As per the report by GSMA and ABI Research[4] on 'Wireless Backhaul Evolution-Delivering next-generation connectivity' of February 2021, while optical fibre will play an important role, microwave backhaul will account for the majority of global backhaul links from 2021 to 2027, with around 65% market share. However, the continued use of wireless backhaul will require an evolution

[3] Chapter 2 of the C&AG Report No. 21 of 2018 (https://cag.gov.in/webroot/uploads/download_audit_report/2018/Report_No_21_of_2018_Compliance_and_Performance_Audit_of_Union_Government_Ministry_of_Communications_.pdf)

[4] Wireless Backhaul Evolution-Delivering next-generation connectivity, February 2021 https://www.gsma.com/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

toward higher frequency bands, which can support wider channels and have a greater total amount of spectrum available. The E-band (70/ 80 GHz) will be important across all regions and is expected to enjoy exceptional growth with an 11.6% CAGR from 2021 to 2027. In more developed markets, even higher frequency bands are likely to be important. The W-band (92 GHz to 114 GHz) and D-band (130 GHz to 175 GHz) are expected to start to gain global traction from 2025 onward. The figure given below shows the details of the spectrum bands being used or are being considered in the near future for wireless backhaul:

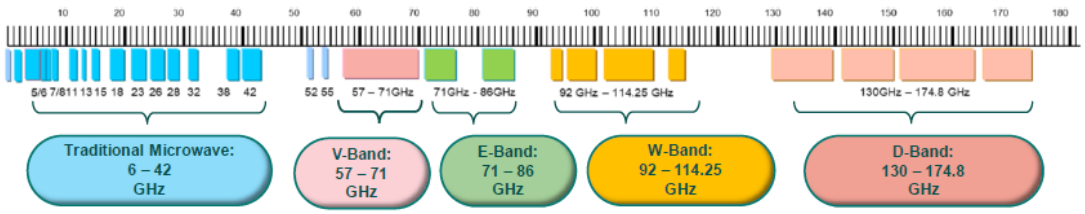

Figure 2.3: Spectrum bands being used/ considered for use in near future for wireless backhaul, Source: ITU

2.10 The said report on 'Wireless Backhaul Evolution-Delivering next-generation connectivity', further mentions that the traditional microwave bands (6 GHz to 42 GHz) continue to have an important role to play, especially as they can cover longer distances with fewer hops.

2.11 Ericsson in its report on Microwave Outlook (2022)[5] mentions that there are around 10 million transceivers installed for backhaul around the world and new deployments in the traditional bands (6 GHz to 42 GHz) remain the backbone for wireless backhaul. The following figures depict regional usage of microwave spectrum, where the size of each circle represents the installed base and new deployment share per frequency range.

[5] Ericsson Microwave Outlook, October 2022 (https://www.ericsson.com/4a81b8/assets/local/reports-papers/microwave-outlook/2022/ericsson-microwave-outlook-report-2022.pdf)

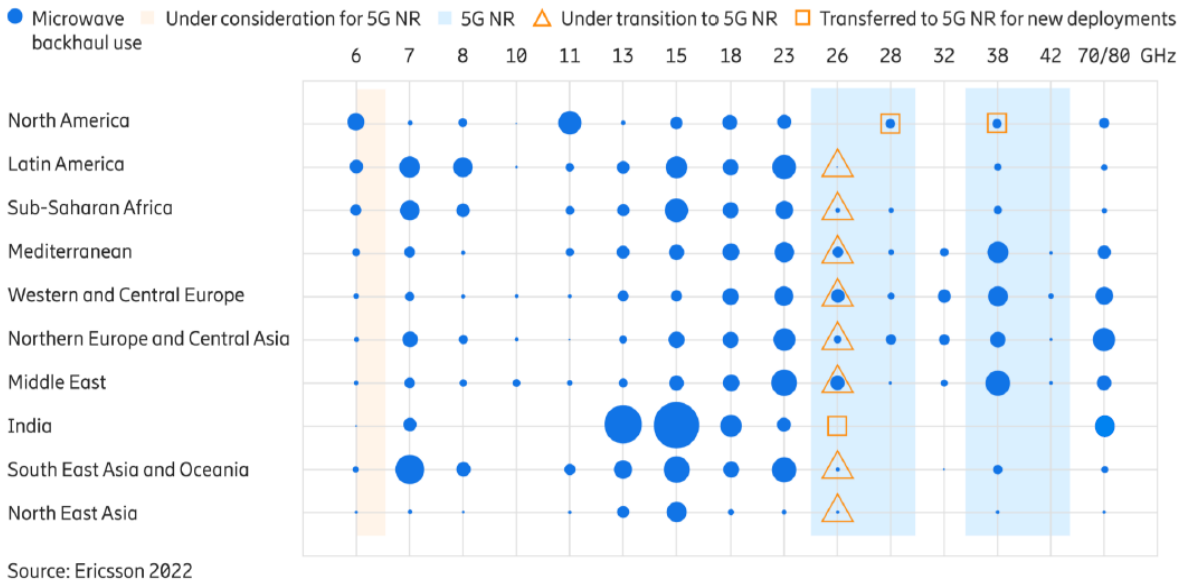

Figure 2.4: Regional usage of microwave spectrum, Source: Ericsson

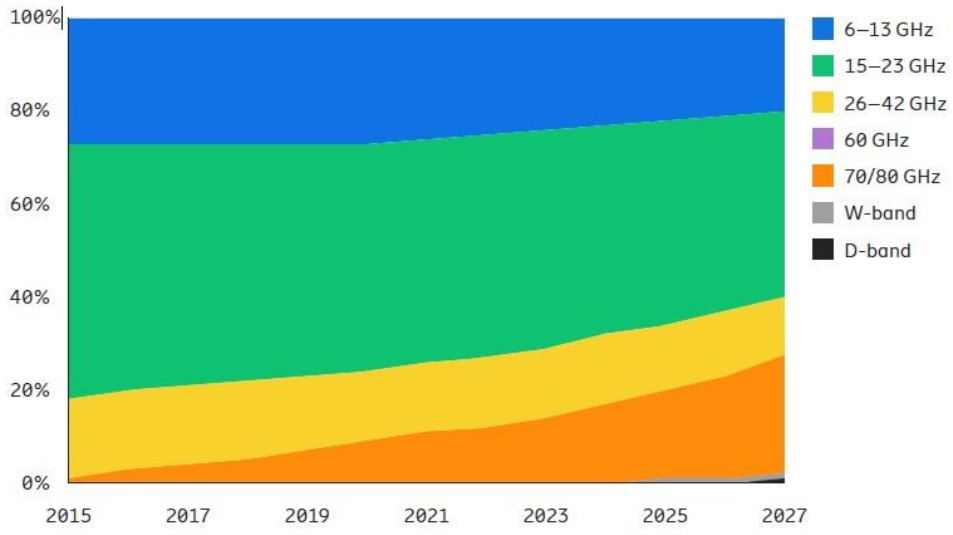

Figure 2.5: New deployment share per frequency range, Source: Ericsson

2.12 The following table provides a comparison of various means of backhaul technologies.

Segment	Microwave (7–40 GHz)	V-Band (60 GHz)	E-Band (70/ 80 GHz)	Fiber-optic	Copper (Bonded)	Satellite
Future-Proof Available Bandwidth	Medium	High	High	High	Very Low	Low
Deployment Cost	Low	Low	Low	Medium	Medium/ High	High
Suitability for Heterogeneous Networks	Outdoor Cell-Site/Access Network	Outdoor Cell-Site/Access Network	Outdoor Cell-Site/Access Network	Outdoor Cell- Site/ Access Network	Indoor Access Network	Rural only
Interference Immunity	Medium	High	High	Very High	Very High	Medium
Range (Km)	5~30, ++	1~	~3	<80	<15	Unlimited
Time to Deploy	Weeks	Days	Days	Months	Months	Months

Table 2.1: Various Mobile Backhaul Technologies[6], Source: GSMA

2.13 Over a period, optical fibre has evolved as the most practical wired solution for backhaul, considering its extraordinary capacity. Owing to its almost limitless capacity and scalability, it is the right choice for high-capacity routes where logistics are manageable, the capacity need is high, and the potential revenue gain offsets the expense. In the coming years, its share in the mobile backhaul network is likely to go up owing to the expected growth in the data traffic and the increasing requirement of backhaul for new technologies such as LTE, LTE-Advanced, IMT-2020 etc.

2.14 The National Broadband Mission[7] released by DoT in December 2019, envisaged to increase by around two and half times the number of fiberized telecom towers in the country. The National Broadband Mission, 2019 had set the 5-year target as below:

[6] GSMA Report on 'Mobile backhaul options - Spectrum analysis and recommendations' of September 2018

[7] https://dot.gov.in/sites/default/files/National%20Broadband%20Mission%20-%20Booklet_0.pdf?download=1

	1-year	2-year	3-year	4-year	5-year
Fiberization of Telecom Towers (%) Cumulative	35	45	55	65	70

Table 2.2: Target of Fiberization of Telecom Towers[8]

2.15 As per the press release dated 22.07.2022[9] issued by the Ministry of Communications on the progress on the National Broadband Mission, *"[a]pproximately 35.11% of Telecom Towers/ BTSs are fiberized as on June 2022. It is envisaged to be increased up to 70% by 2024-25."* However, as can be seen from the above, the year-on-year target of the National Broadband Mission is lagging.

B. TRAI's earlier recommendations on 'Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers' of 2014

2.16 In 2012, DoT through a reference letter dated 26.11.2012 had sought TRAI's recommendations on the following:

a) Methodology for Allocation and Pricing of MW Access and Backbone (MWA/ MWB) carriers for new service providers and the existing service providers for initial and additional allocations of MW Access and MW backbone carriers.

b) Criteria for withdrawal of excess allocation of MWA and MWB carriers from existing service providers.

c) Annual spectrum usage charges and criteria for pricing for different bands of MWA and MWB carriers including any upfront charges, along with date of applicability.

[8] GSMA Report on 'Mobile backhaul options - Spectrum analysis and recommendations' of September 2018

[9] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1843752

2.17 In response, TRAI provided recommendations on '*Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers*' dated 29.08.2014. A few recommendations relating to MWA/ MWB are reproduced below:

"5.1 TSPs should be assigned MWA carriers as per their requirement. However, it will be subject to a ceiling on the number of MWA carriers that can be assigned to a TSP as given in Table 2.5 below.

Table 2.5

Maximum No. of MWA carriers that can be assigned to a TSP

Quantum of Access Spectrum that a Licensee has in a LSA	***Metro/ Cat 'A' Circles***	***Cat 'B' Circles***	***Cat 'C' Circles***
Less than 2.5 MHz	*3*	*2*	*2*
2.5 MHz or more but < 5 MHz	*4*	*3*	*2*
5 MHz or more but < 10 MHz	*5*	*4*	*3*
10 MHz or more but < 15 MHz	*6*	*5*	*4*
15 MHz or more but < 20 MHz	*7*	*6*	*5*
20 MHz or more but < 30 MHz	*8*	*7*	*6*
30 MHz or but <40 MHz	*9*	*8*	*7*
40 MHz or more	*10*	*9*	*8*

Note:

1. If any TSP requires carriers in addition to what have been recommended above, it may be examined by the DoT on a case-to-case basis.

2. It has been assumed that each carrier is of size 2x28 MHz. Carrier of 2x56 MHz and 2x112 MHz should be counted as 2 and 4 carries respectively when applying the above ceiling.

3. Access spectrum indicated in this table is a paired spectrum. Therefore, unpaired access spectrum shall be counted as half for the purpose of applying the above ceilings e.g. 20 MHz of unpaired spectrum

in the 2300 MHz band shall be considered as equivalent to 10 MHz (paired).

4. The above ceilings may be reviewed periodically.

(Para 2.22)

5.2 TSP should be assigned MW carriers as per their request as long as it is within the ceiling limit recommended in Para 2.22(Para 2.29)

5.3 TSPs, holding MWA carriers in excess of the maximum number of carriers recommended by the Authority in Para 2.22, should be asked to surrender the excess MWA carriers in one year's time period with effect from the date the new guidelines come into force. However, in case TSP is left with excess MWA carriers as a result of trading of spectrum, it will have to surrender the excess MW carriers within three months of the effective date of trade. In case TSP wants to retain them, it should be permitted to do so, only if it is able to justify the need of additional carriers to the satisfaction of the DoT. (Para 2.40)

5.4 [I]n future, no TSP should be assigned more than 4 MWA carriers in the 13/15 GHz band. In other bands too, there should be equitable distribution of carriers as far as possible. However, this would not have any impact on existing assignments. This is because of the fact that any re-arrangement of MWA carriers already assigned to TSPs will force them to redesign their network which will require them to incur significant costs. (Para 2.43)

5.5 [T]he assignment of MWA carriers should be done on an exclusive basis for the various spectrum bands in 13-42 GH. z range whereas the assignment of MWB carriers should be done on a link-to-link basis. (Para 2.58)

5.6 [T]he assignment of MWA and MWB carriers should continue to be done administratively. (Para 2.62)

5.7 [T]he assignment of MWA and MWB carriers should continue to be done administratively.

i. The assignment of MWA carriers should be done for the entire LSA.

ii. Assignment of both access spectrum and MWA carriers should be done simultaneously within a period of one month from the date the TSP makes the payment for access spectrum, failing which TSP should be paid compensation at the SBI PLR rate of the amount it had already paid to acquire the access spectrum.

iii. In case of delay in the assignment of MWA carriers for a new TSP in a LSA, the effective date of access spectrum assignment may be taken as the date of assignment of the first MWA carrier.

(Para 2.69)

5.8 [T]he higher frequency bands viz. 26 GHz, 28 GHz, 32 GHz, 38 GHz and 42 GHz should be earmarked for fixed point-to-point MW carriers and the channeling plan should be kept in line with the ITU-R recommendations. The Authority is also of the view that larger carriers of size 56 MHz (paired) and 112 MHz (paired) should also be assigned to the TSPs in these bands. As the number of assignments made in the 21 GHz band is quite small, the DoT may also examine the feasibility of assigning larger carrier sizes in this band. (Para 2.80)

5.10 [T]here should not be any upfront charges for the assignment of MWA and MWB carriers. (Para 3.17)

5.11 [T]he AGR based spectrum charging mechanism for MWA carriers should be continued. However, for MWB carriers, the charging should be done on a link-to-link basis as is being done for all other terrestrial MW links. (Para 3.25)

5.12 [T]he following spectrum charges for MWA carriers (28 MHz paired) should be made applicable for access service providers.

Table 3.7

No. of MWA carriers assigned to a TSP	***Applicable Percentage of AGR as spectrum charge for MWA carriers***			
	13/15 GHz	***18/21 GHz***	***26/28/32***	***38/42 GHz***
1	*0.17%*	*0.12%*	*0.10%*	*0.07%*
2	*0.34%*	*0.24%*	*0.20%*	*0.14%*
3	*0.51%*	*0.36%*	*0.30%*	*0.21%*
4	*0.68%*	*0.48%*	*0.40%*	*0.28%*
5	*0.85%*	*0.60%*	*0.50%*	*0.35%*

Note: For larger carrier sizes, spectrum charges shall increase proportionately. i.e. if the TSP has two carriers of 2x56 MHz of carriers in 18/21 GHz band, it shall be charged at 0.48% of AGR.

(Para 3.40)

5.13 [I]f a TSP, holding MWA carriers in excess of the maximum number of carriers recommended by the Authority in Para 2.22, fails to justify the retention of additional carriers to the DoT and does not surrender the excess MWA carriers within the specified time limits (i.e. either one year or three months as the case may be), it shall be liable to pay an additional 25% of total MWA spectrum charges that the TSP is otherwise liable to pay for the period in excess of permissible period. (Para 3.42)

5.14 [[S]pectrum charges for MWB link shall be Rs. 13,900 per KM per annum. (Para 3.57)

5.15 [P]resent spectrum charges for terrestrial Point-to-Point MW links (other than MWB links used in cellular network) should be rationalized and should be the same as have been recommended for MWB links. (Para 3.60)

2.18 On some of the issues, DoT sought clarification/ reconsideration on TRAI's recommendations dated 29.08.2014 through back reference dated 16.10.2015. For the recommendations, as mentioned in para 2.17 above (Recommendations 5.1 to 5.7), DoT in its back-reference mentioned that:

(I) In these recommendations, TRAI has proceeded on its promise that MWA and MWB carriers should be allotted on administrative basis, mainly on the following grounds:

(i) There is sufficient availability of carriers in MWA bands and other new bands can also be opened.

(ii) MWA carriers are important for roll out and adoption of auction mechanism for MWA carriers may act as a barrier for new entrants due to uncertainty about availability of MWA carriers.

(iii) Since access spectrum is assigned through auction, there seems to be no justification for another auction for assignment of microwave carriers, as these will be used by the telecom service providers (TSPs) having access spectrum.

(iv) Stakeholders have indicated that auction should be preferred method when demand is expected to exceed supply and currently carriers are available in abundance.

(v) For MWA carriers, link by link allotment requires interference management by WPC Wing, which is very difficult exercise.

(II) TRAI has recommended that MWA carriers may be allotted on exclusive basis for the LSA while MWB carriers be allotted on link to link basis, as per the existing practice.

(III) With the above background, the TRAI has, inter-alia, recommended ceiling on number of MWA carriers by linking it to the quantum of spectrum held, surrender of excess spectrum held, allotment in future of MWA carriers 13/ 15 GHz bands, exclusive allotment of MWA carriers in 13-42 GHz bands, link by link allotment of MWB carriers and final finally simultaneous allotment of access spectrum (through auction) and MWA carriers (within one month of payment for access spectrum) failing which, effective date of access spectrum should be shifted and compensation may be paid to the TSP.

(IV) TRAI is requested to reconsider its recommendation for MWA / MWB bands, taking into account the facts as detailed in Annexure-A.

(IV.1) Microwave Access Spectrum (MWA):

The TRAI is requested to re-consider its recommendations for administrative allocation of MWA taking into account the facts mentioned in Annexure-A. In case reconsidered opinion on method of allotment is through auction or any other appropriate methodology ensuring transparency and taking into account the judgement of Hon'ble Supreme Court of India in 2G case, TRAI is requested to recommend reserve price, Spectrum Usage Charge (SUC), quantum of spectrum/ carriers to be allotted to the existing licensees holding MWA spectrum and licensees who do not hold MWA spectrum, migration path for existing administratively allocated MWA spectrum to auction based allocation of MWA spectrum, methodology of auction and associated terms and conditions.

(IV.2) Microwave Backbone Spectrum (MWB):

It is noted that microwave backbone carriers are allotted on link to link basis in a service area or between service areas and not on exclusive basis i.e. same carrier can be allotted to more than one operator (which is not the case for MWA spectrum). The SUC is levied on the basis of percentage of AGR. Further, allotment of MWB carriers through auction may result in exclusivity for successful bidders and this sub-optimal use of MWB carriers as the usability of the frequency spots by other licensees will be blocked.

However, in the light of the Supreme Court judgement of 02.02.2012 in 2G case, it is clear that while allotting spectrum, the issues relating to 'First Come First Served' (FCFS) as well as auction of spectrum are to be addressed. TRAI in its recommendations has suggested that Microwave Spectrum should continue to be allotted administratively. Any administrative allotment follows the principle of FCFS which has been denounced by the Supreme Court.

Further, there may be instances where a particular spot frequency is claimed by two licencees and the policy should provide for resolution of such situations.

Therefore, the TRAI is requested to re-consider its recommendations for allotment of microwave backbone spectrum. TRAI is also requested to recommend methodology of allocation of spectrum/carriers to all categories of telecom licensees, methodology of charging including whether it can be linked to market discovered prices in some other band or not and associated terms and conditions.

In addition, the TRAI is also requested to provide its reconsidered recommendations on methodology and pricing for allotment of carriers in these bands to users other than telecom service providers.

2.19 After due consideration, TRAI gave response to the DoT's back-reference dated 16.10.2015 on 17.11.2015. The relevant extract is given below:

"The Authority, after carefully going through the back reference, has noted that the main issue raised by DoT, in all the Microwave bands recommended by the Authority, is regarding allocation methodology of MWA and MWB carriers on administrative basis. Primarily, the DoT has asked the Authority to reconsider its recommendations with regard to assignment of Microwave carriers on administrative basis, stating that as administrative allotment follows the principle of 'first come first served' and the same has been denounced by the Supreme Court in its judgement on the 2G case.

Regarding allocation methodology of MW carriers, the Authority in chapter-2 of the recommendations in paras 2.18 to 2.29 and paras 2.44 to 2.62, has elaborately explained the rationale for continuing with the existing assignment methodology which was on administrative basis. Regarding query of DoT on legal issue of assignment methodology raised in paras from 5.1 to 5.7 and 5.10 to 5.15 of the back reference, the Authority has already communicated its stand vide its letter No. 102-6/2014-NSL-II dated 8th July, 2015 (Copy enclosed as Annexure-II). Further, a letter No. 102-6/2014-NSL-II dated 14th October, 2015 in this regard was also written."

C. Examination of issues relating to assignment of MWA and MWB RF carriers in existing frequency bands (6/7/13/ 15/ 18/ 21 GHz)

2.20 DoT through its reference dated 12.08.2022 requested TRAI to provide its recommendations, inter-alia, on allocation methodology, quantum, and pricing of MWA and MWB RF carriers in 6/7/12/15/18/21 GHz bands for establishment of terrestrial and/ or satellite-based telecom networks as well as non-commercial/ captive/ isolated use.

(a) Bands and quantum of spectrum

2.21 As per the information provided by DoT, spectrum for MWB is assigned in 6 GHz and 7 GHz bands and spectrum for MWA is assigned in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands. Details of these bands are given below:

	Band	Frequency range	No. of carriers	Adjacent channel separation	Tx-Rx separation
MWB	6 GHz	5925-6425 MHz	8	29.65 MHz	252.04 MHz
	7 GHz	7125-7425 MHz	5	28 MHz	161 MHz
		7425-7725 MHz	5	28 MHz	154 MHz
MWA	13 GHz	12.75-13.25 GHz	8	28 MHz	266 MHz
	15 GHz	14.5-15.5 GHz	15	28 MHz	420 MHz
	18 GHz	17.7-19.7 GHz	32	27.5 MHz	1010 MHz
	21 GHz	21.2-23.6 GHz	40	28 MHz	1232 MHz

Table 2.3: Details of MWA and MWB frequency bands

2.22 Spectrum for MWA is assigned to the TSPs with access service authorization on carrier basis i.e., a carrier assigned to a TSP can be used anywhere within the Licensed Service Area (LSA[10]), while spectrum for MWB is assigned on a point-to-point link basis. Charging for MWA as well as MWB spectrum assignments is done on a percentage of AGR basis. However, the applicable rate as a

[10] *LSA refers to Telecom Circle/Metro service area as defined for Access Service Authorization under the Unified License*

percentage of AGR does not vary with the number of P2P links demanded/ assigned in a carrier to a TSP. For TSPs other than Access Service Authorization, and other entities i.e., non-TSP isolated captive users, MWA/ MWB carriers are assigned on a point-to-point (P2P) link basis. Charging for such spectrum assignments is done on a formula basis.

2.23 Details of the frequency carriers in each MWA and MWB band, as provided by the DoT, are enclosed as **Annexure-2.1**.

2.24 Since MWB carriers are assigned on P2P basis, multiple links at different locations (latitude-longitude combinations) can be created. Therefore, there may not be any limitation on the number of carriers that can be assigned to a TSP on P2P basis. However, from the present spectrum assignment details provided by DoT, it is observed that assignments have been made in only a few carriers in MWB bands. In 5 out of 8 Carriers in 6 GHz band, there is no spectrum assignment to the Access Service Licensees. In the 7 GHz (7125-7425 MHz) band, out of 5 carriers, only one carrier in 12 LSAs has been assigned to the access service providers; thus, this band is largely unutilized. In 7 GHz (7425-7725 MHz) band, it is observed that on average, about 50% of the carriers are unutilized.

2.25 In MWA bands, i.e., 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands, the details of the carriers assigned to the telecom service providers with access service license/ authorization are given below:

LSA	13 GHz (Total no. of carriers = 8)	15 GHz (Total no. of carriers = 15)	18 GHz (Total no. of carriers = 32)	21 GHz (Total no. of carriers = 40)
Andhra Pradesh	4	13	6	1
Assam	3	11	3	1
Bihar	3	12	2	-
Delhi	4	14	9	8
Gujarat	7	12	7	-
Haryana	3	11	3	-
Himachal Pradesh	6	12	1	-
Jammu and Kashmir	3	8	5	1
Karnataka	4	14	6	3
Kerala	3	11	5	3

LSA	13 GHz (Total no. of carriers = 8)	15 GHz (Total no. of carriers = 15)	18 GHz (Total no. of carriers = 32)	21 GHz (Total no. of carriers = 40)
Kolkata	-	15	11	1
Madhya Pradesh	3	14	2	-
Mumbai	4	10	17	9
Maharashtra	2	11	9	-
North East	3	9	4	1
Orissa	3	11	5	-
Punjab	3	14	4	1
Rajasthan	6	12	6	-
Tamil Nadu	4	11	5	3
Uttar Pradesh (East)	6	11	4	-
Uttar Pradesh (West)	6	13	6	1
West Bengal	3	11	5	1

Table 2.4: Details of MWA carriers assigned to Access Service Providers

2.26 From the above table, it can be seen that the most used MWA band is the 15 GHz band. On average, 50% of carriers in the 13 GHz band have been assigned to the Access Service Providers and 18 GHz and 21 GHz bands are largely unutilized.

2.27 From the information on spectrum assignment provided by DoT, it is observed that the spectrum for MWA and MWB assigned to the Telecom service providers with Access Service License/ Authorization has been shared. However, there could be some assignments to the TSPs other than Access Services licensees and to other entities (non-TSP) for isolated captive use. Therefore, to assess the quantum of spectrum required for different types of users viz. Access service providers, TSPs other than access service authorizations, and other entities (non-TSP for non-commercial/ captive/ isolated use), information from the stakeholders needs to be gathered.

2.28 As per the existing framework, MWA carriers are assigned to the TSPs with Access Service authorization exclusively on LSA basis and for TSPs other than access service authorizations, and other entities (non-TSP for non-commercial/ captive/ isolated use), assignments are made on point-to-point link basis. As regards MWB carriers, carriers are assigned on point-to-point link basis to all

types of entities. One may contend that MWB carriers should also be assigned exclusively on LSA basis. The contrary argument could be that there are a limited number of carriers in MWB bands and the deployment of MWB carriers may not require exclusive assignment; further, exclusive assignment may result in sub-optimal use of MWB carriers. Exclusive assignment of MWB carriers on LSA basis, may also involve other practical issues. For instance,

(a) NLD service provider may want to use MWB link to connect two nodes falling in different LSAs. If spectrum is assigned on an LSA basis, it cannot be guaranteed that the same carrier is assigned in both the LSAs. Assuming that same carrier is assigned in both the LSAs, a provision may have to be created to permit it to utilize spectrum assigned on LSA basis, for across LSA deployment.

(b) ISP with 'C' Category license/authorization, whose Service Area is Secondary Switching Area (SSA), which is smaller than the concerned LSA, may also like to have MWA/ MWB carrier.

2.29 Therefore, issue arises is whether spectrum for MWA and MWB should be assigned on P2P link basis or for entire LSA for different types of users viz. Access Service Providers, other TSPs, other entities (non-TSP for non-commercial/ captive/ isolated use).

2.30 Further, some of the MWA/MWB bands are overlapping with fixed satellite services (FSS) bands. Details of the bands overlapping with the FSS are:

Spectrum Band	**Frequencies allocated for FSS**	
6 GHz	5725-6700	Earth to Space
7 GHz	7250-7750	Earth to Space
13 GHz	12.75-13.25	Earth to Space
18 GHz	17.7-19.7	Space to Earth

Table 2.5: Details of MWA/ MWB spectrum bands overlapping with FSS

2.31 As already mentioned, DoT through its reference dated 12.08.2022 has requested TRAI to provide its recommendations, inter-alia, on allocation methodology, quantum and pricing of MWA and MWB RF carriers in 6/7/12/15/18/21 GHz bands for establishment of terrestrial and/or satellite-based telecom networks as well as non-commercial/captive/isolated use. In this regard, it is noted that some of these bands have been explicitly referred by DoT for auction of spectrum for space-based communication services to TRAI seeking recommendations. For space-based communication services, TRAI has already issued a consultation paper on 'Assignment of Spectrum for Space-based Communication Services' dated 06.04.2023[11]. Further, it may be mentioned that, at present, MWA/ MWB based terrestrial networks coexist with fixed satellite services. For this, ITU has provided an elaborate framework for coexistence of terrestrial services and space-based communication services.

2.32 Further, in response to TRAI's letter dated 09.09.2022, DoT through its letter dated 11.10.2022, inter-alia, informed that study has begun at ITU under agenda item 9.1(c) for use of Fixed services spectrum band (that includes Backhaul bands also) for use in IMT System for providing fixed broadband services. It is noted that WRC-23 agenda item No. 9.1(c) is to study the use of International Mobile Telecommunication systems for fixed wireless broadband in the frequency bands allocated to the fixed services on primary basis, in accordance with Resolution 175 (WRC-19). In this regard, the report of the Conference Preparatory Meeting (CPM)[12] on technical, operational and regulatory/ procedural matters to be considered by the World Radiocommunication Conference 2023 has noted that:

> *'Input contributions were received proposing updates to some of these existing ITU-R Recommendations/Reports. Other input contributions proposed new ITU-R Reports and Recommendations to address required studies by WRC-23 agenda item 9.1, topic c). All input contributions were*

[11] https://www.trai.gov.in/sites/default/files/CP_06042023.pdf

[12] https://www.itu.int/dms_pub/itu-r/md/19/cpm23.2/r/R19-CPM23.2-R-0001!!PDF-E.pdf

introduced in the joint activity of WPs 5A and 5C but were not fully discussed and no agreement was found on a single way forward.'

2.33 In this background, the Authority solicits comments of stakeholders on the following set of questions:

Issues for Consultation

Q1. What quantum of spectrum in different MWA and MWB frequency bands is required to meet the demand of TSPs with Access Service License/ Authorization? Whether MWA/ MWB spectrum is also required by TSPs having authorizations other than Access Service License/ authorization, and other entities (non-TSP, for non-commercial/ captive/ isolated use)? Information on present demand and likely demand after five years may kindly be provided as per the proforma given below with detailed justification:

(i) Present demand

Band	**Quantum of spectrum required (per entity per LSA)**		
	TSPs with Access Service License/ Authorization	**TSPs with other than Access Service License/ Authorization**	**Other entities (non-TSP, for non-commercial/ captive/ isolated use)**
6 GHz (5.925-6.425 GHz)			
7 GHz (7.125-7.425 GHz)			
7 GHz (7.425-7.725 GHz)			
13 GHz (12.750-13.250 GHz)			
15 GHz (14.5-15.5 GHz)			

18 GHz (17.7-19.7 GHz)			
21 GHz (21.2-23.6 GHz)			

(ii) Likely demand after five years

Band	**Quantum of spectrum required (per entity per LSA)**		
	TSPs with Access Service License/ Authorization	**TSPs with other than Access Service License/ Authorization**	**Other entities (non-TSP, for non-commercial/ captive/ isolated use)**
6 GHz (5.925-6.425 GHz)			
7 GHz (7.125-7.425 GHz)			
7 GHz (7.425-7.725 GHz)			
13 GHz (12.750-13.250 GHz)			
15 GHz (14.5-15.5 GHz)			
18 GHz (17.7-19.7 GHz)			
21 GHz (21.2-23.6 GHz)			

Q2. Whether spectrum for MWA and MWB should be assigned for the entire LSA on an exclusive basis, or on Point-to-Point (P2P) link basis? Response may be provided separately for (i) TSPs with Access Service License/ Authorization, (ii)TSPs having authorizations other than Access Service License/ authorization, and (iii) Other entities

(non-TSP, for non-commercial/ captive/ isolated use) in the table given below with detailed justification:

Microwave bands	Spectrum should be assigned for the entire LSA on an exclusive basis, or on P2P link basis for -		
	TSPs with Access Service License/ Authorization	**TSPs with other than Access Service License/ Authorization**	**other entities (non-TSP, for non-commercial/ captive/ isolated use)**
MWB (6/7 GHz)			
MWA (13/15/18/21 GHz)			

Q3. Keeping in view the provisions of ITU's Radio Regulations on coexistence of terrestrial services and space-based communication services for sharing of the same frequency range, do you foresee any challenges in ensuring interference-free operation of terrestrial networks (i.e., MWA/ MWB point to point links in 6 GHz, 7 GHz, 13 GHz, and 18 GHz bands) and space-based communication networks using the same frequency range in the same geographical area? If so, what could be the measures to mitigate such challenges? Suggestions may kindly be made with justification.

(b) Carrier size

2.34 GSMA report on 'Wireless Backhaul Evolution - Delivering next-generation connectivity' of February 2021 mentions that the traditional microwave bands (i.e., within 6 GHz to 42 GHz) continue to have an important role to play, especially as they can cover longer distances with fewer hops. However, their narrower channel sizes make supporting 5G traffic challenging, so it is important that regulators support wider channels and permit operators to

aggregate spectrum in these bands. GSMA report also provides a table depicting typical channel size in microwave bands. As published in the GSMA report, the following figure shows the typical Channel Sizes, and Data Throughput in traditional microwave bands.

Main Backhaul Bands	Typical Channel Sizes in 2020 (MHz)	Data Throughput (GBps)	Typical Channel Sizes in 2027 (MHz)	Data Throughput (GBps)
6-13 GHz	28	0.25	56	0.5
	40	0.36	80	0.7
14-25 GHz	28	0.25	56	0.5
	56	0.5	112	1.0
26-56 GHz	56	0.5	112	1.0
			224	2.0

Figure 2.6: Typical channel sizes and data throughput in traditional microwave bands, Source: GSMA

2.35 At present, in India, the carrier size followed for assignment of MWA and MWB is 28 MHz. However, TSPs can acquire more than one carrier. In case, a TSP acquires multiple carriers to meet the high-capacity requirement, one option could be the use of wider channel size (provided assigned carriers are contiguous) and the other option could be the use of carrier aggregation technique. One may contend that considering that the backhaul capacity requirement has increased manifolds, the carrier size may be increased. One could also argue that the data traffic in certain LSAs or category of LSAs is comparatively higher; therefore, for such LSAs, a larger carrier size may be advisable. Contrary view could be that a lower carrier size provides greater flexibility and TSP, anyway, has a choice to obtain multiple carriers of 28 MHz. At this point, a question arises as to what should be the carrier size for MWA and MWB bands.

2.36 Further, some of the MWA/ MWB bands are quite wide and there may be a case that the available equipment may not be supporting the entire band but part of the frequency band. In such a case, it may be desirable that if a TSP acquires more than one carrier, all the carriers are assigned in a contiguous manner to enable carrier aggregation, or use of wider channel. Further, the

frequency range should be such that a single equipment can cater to all the assigned carriers.

2.37 It is also noted that, DoT is presently assigning MWA/ MWB carriers on a temporary and provisional basis with certain terms and conditions, including the following:

"All MWA/ MWB carrier/ spectrum allotted, as an interim measure, will be purely on temporary and provisional basis and all such allotees will have to participate in the allotment methodology as decided by the Government after considering the recommendations of TRAI on the subject."

2.38 Therefore, the existing licensees holding MWA/ MWB carriers will have to participate in the allotment methodology as decided. For the existing TSPs using MWA and MWB carriers, change in the carriers, already in use, may not be any issue as far as the equipment is supporting the new carrier; otherwise, any change in frequency carrier could result in disruption of services or deterioration of quality of service for the customers. To avoid disruption of services due to carrier reassignment, as per the new carrier assignment methodology, there may be a need to ensure that the newly assigned frequency carriers to a TSP are supported by the existing equipment of the TSP. One solution could be to assign the already assigned carriers to a TSP as long as the TSP is able to acquire the required number of carriers in the new regime. In case a TSP decides to acquire a lesser number of carriers, it can be given a choice to surrender the remaining number of carriers considering its deployment in the existing network.

2.39 In this background, the Authority solicits comments of stakeholders on the following set of questions:

Issues for Consultation

Q4. What should be the carrier size for MWA and MWB carriers in each band viz. 6/7/13/15/18/21 GHz bands? Whether there is a need to

prescribe a different carrier size based on different LSA categories or different user categories viz. (i) TSPs with Access Service License/ Authorization, (ii) TSPs with other than Access Service License/ Authorization and (iii) other users (non-TSP, for non-commercial/ captive/ isolated use)? If yes, suggestions may be made in the table given below with detailed justification.

Microwave bands	Carrier size (in MHz) for -		
	TSPs with Access Service License/ Authorization	**TSPs with other than Access Service License/ Authorization**	**other users (non-TSP, for non-commercial/ captive/ isolated use)**
MWB (6/7 GHz)			
MWA (13/15/18/21 GHz)			

Q5. Whether there is a need to assign MWA and MWB carriers in such a way that if a TSP acquires more than one carrier in a band, all assigned carriers are contiguous, and assigned frequency range(s) can be catered through a single equipment? If yes, kindly provide details of the frequency range(s) supported by the available equipment in each band. Any other suggestion(s) may kindly be made with detailed justification?

Q6. For the existing service licensees holding MWA/ MWB carriers, whether there is a need to create some specific provisions (as discussed in para 2.38 of this CP) such that if the licensee is successful in acquiring the required number of carriers through auction/ assignment cycle, its services are not disrupted? If yes, kindly provide a detailed response with justification.

(c) Maximum number of carriers per Licensee

2.40 The objective of prescribing the maximum number of carriers that a Licensee can hold is to prevent large holdings of carriers by one or a few TSPs, which may create concerns for the competition in the market.

2.41 As per the guidelines of 2015, the TSPs could be allotted a maximum of 4 MWA carriers for Metro & Category A Service Area and 3 MWA carriers for Category B and Category C Service Area. Considering the increased requirements of backhaul on account of 5G, through amendment dated 25.07.2022, DoT increased the limit of maximum number of Microwave Access carriers that can be assigned to a Telecom Service Provider with Access Service authorization/ license on provisional basis to 8 carriers for Metro & Category A Service Area and 6 carriers for Category B and Category C Service Areas. For TSPs having other than access service license/ authorization, MWA carriers are assigned on P2P link basis. In respect of MWB carriers, as per the guidelines of 2015, Microwave Backbone carrier(s) are allotted on link-to-link basis subject to availability.

2.42 TRAI in its earlier recommendations of 2014 recommended maximum number of carriers that can be assigned to a TSP in each category of LSAs based on the access spectrum held by the TSP. Considering the increasing data usage of the consumers, fiberization of cell sites has also increased over a period. High-capacity E-band has also been opened by the Government. Further, various technologies have been evolved to enhance the backhaul data throughput i.e., high throughput is possible with the same quantum of spectrum with use of technologies such as Cross polarization interference cancellation (XPIC[13]).

2.43 In view of the foregoing discussion, the stakeholders may provide their comments on the following issues.

[13] XPIC involves transmitting signals on both the horizontal and verticals planes using the same radio channel and eliminating the interference from the second polarisation; doubling spectrum efficiency.

Issues for Consultation

Q7. Whether there is a need to review the existing ceiling on number of MWA carriers that can be held by a licensee? In case it is decided to review the ceiling on the number of MWA carriers that a licensee can hold,

(a) Whether a separate ceiling for each band (13 GHz/ 15 GHz/ 18 GHz/ 21 GHz) should be prescribed or an overall ceiling for MWA carriers taking all bands together?

(b) Whether different ceilings based on the service area category i.e., Metro/ Category 'A' Circles/ Category 'B' Circles/ Category 'C' Circles, needs to be prescribed?

(c) What should be the ceiling in terms of the number of carriers of 28 MHz per licensee in each case i.e., band-wise ceiling and overall ceiling for each service area category for -

(i) TSPs with Access Service License/ Authorization , and

(ii) TSPs with other than Access Service License/ Authorization?

(d) Any other relevant suggestion may be made with justification.

Kindly justify your response.

Q8. In case it is decided to assign MWB carriers exclusively on LSA basis to the TSPs, whether there is a need to prescribe any ceiling on the maximum number of MWB carriers that can be held by a TSP? Kindly justify your response.

Q9. In case it is decided to prescribe a ceiling on the number of MWB carriers that a TSP can hold,

(a) Whether separate ceiling for each band (6 GHz, 7 GHz (7.125-7.425 GHz) and 7 GHz (7.425-7.725 GHz)) should be prescribed or an overall ceiling for MWB carriers should be prescribed?

(b) Whether different ceiling based on the service area category i.e., Metro/ Category 'A' Circles/ Category 'B' Circles/ Category 'C' Circles, needs to be provided?

(c) What should be the ceiling in terms of number of carriers of 28 MHz per licensee in each case i.e., band-wise ceiling and overall ceiling for each service area category for

(i) TSPs with Access Service License/ Authorization , and

(ii) TSPs with other than Access Service License/ Authorization?

(d) Any other relevant suggestion may be made with justification.

(d) Assignment methodology

2.44 The existing spectrum assignment and re-assignment mechanism of MWA and MWB carriers in 6/7/13/15/18/21 GHz bands, as informed by DoT through its letter dated 11.10.2022 is as follows:

(a) Frequency assignments and re-assignments for MWA/MWB carriers to TSPs having access service license/ authorization, are being considered administratively on provisional basis as per guidelines dated 16.10.2015 (**Annexure 2.2**) and its addendum dated 25.07.2022 (**Annexure 2.3**). As per current practice, the MWA/MWB spectrum assignments to TSPs are co-terminus with the service license. The applicants (TSPs) are required to submit an undertaking, therein following conditions have been mentioned:

"(i) The allotment of spectrum is provisional and subject to Govt's final decision on allotment & pricing of MWA and MWB spectrum;

(ii) In the event of final decision to allot spectrum only through auction process, the provisional allotment of spectrum shall be withdrawn;

(iii) In case the provisional allotment of spectrum is withdrawn, payment made towards spectrum charges or part thereof shall not be refunded;

(iv) In case the provisional allotment of spectrum is withdrawn, respective wireless users would obtain Non Dealer Possession Licence (NDPL) for possessing the wireless equipment or return the equipment to a DPL holder or shall be disposed off the same as per procedure.

(v) The revised spectrum charges, as finally determined through market related mechanism or otherwise, as may be applicable, shall be paid by us from the date of issue of Letter for provisional allotment of spectrum."

(b) For other entities and satellite networks the frequency assignments are being considered as per the interim policy issued from time to time and upon an undertaking containing, among others, that the allotment of spectrum is provisional and subject to the Government's decision on allotment and pricing of spectrum, and that in the event of the final decision to allot spectrum only through auction process, the provisional allotment of spectrum shall be withdrawn. (Copy of the interim policy as per **Annexure-2.4**)

2.45 To summarize, as per the existing framework, MWA carriers are assigned to the TSPs with Access Service License/ authorization exclusively on an LSA basis, and for other TSPs and other entities, assignments are made on P2P link basis. As regards MWB carriers, carriers are assigned on P2P link basis to all types of entities.

2.46 As already mentioned, DoT in its back reference dated 16.10.2015 had mentioned, inter-alia, that as per the present method, MWA spectrum is allotted

on an exclusive basis in a service area and SUC is levied on the basis of percentage of AGR, whereas MWB carriers are allotted on link basis in a service area or to another service area and not on an exclusive basis (unlike MWA spectrum). It was also mentioned by DoT that auction of MWB carriers may result in sub-optimal use of MWB carriers as usability of those frequency spots by others will be blocked in that service area or across service areas.

2.47 As regards assignment of MWA carriers, one may contend that as MWA carriers are assigned to TSPs with access service license/ authorization on an exclusive basis on LSA basis and the same carrier cannot be assigned to another TSP in the same LSA; therefore, MWA carriers should be assigned through auction.

2.48 For TSPs other than access service license/ authorization, one may also contend that TSPs other than access service license/ authorization should also be assigned MWA carriers on an exclusive basis, similar to the way it is assigned to access service providers. In contrast, one may contend that since TSPs other than access service providers may require to establish a few links only, assignment on P2P link basis may be continued for such TSPs, provided such number of links is within the prescribed limit, beyond which, the TSP may be required to acquire spectrum through auction. Another view could be that the TSPs who may be requiring to establish only a few links could take such links on lease from the TSPs who have acquired spectrum through auction. A counter argument could be that this will result in the development of a secondary market and loss of potential revenue to the exchequer.

2.49 As regards MWB carriers, one may contend that since MWB carriers are assigned on a P2P link basis and the same carrier can be assigned to another TSP in the same LSA but with different Lat-Long combination, as long as they are not likely to cause any interference to one another; therefore, administrative assignment may result in better utilization of spectrum. However, as noted by DoT in its back-reference dated 16.10.2015, there may be instances where a particular spot frequency is claimed by two licensees and therefore, there could be a case of auction. Another view could be that MWB

carriers may also be assigned on an LSA basis and in that case, it can be assigned through auction.

2.50 Other entities (non-TSP) may also be requiring MWA/ MWB links to connect its nodes of the network within an isolated geographical area or two or more premises occupied by such users. In such cases, it may not be feasible to assign P2P links through auction. Further to assign MWA/ MWB carriers on a P2P links basis to such users by any methodology other than auction, some carriers may have to be earmarked for such users.

2.51 It is also noted that as per the Guidelines dated 16.10.2015, all MWA/ MWB carrier/spectrum allotted, as an interim measure, will be purely on temporary and provisional basis and all such allottees will have to participate in the allotment methodology as decided by the Government after considering the recommendations of TRAI on the subject. Further, the Guidelines of 2015 mentions that, *[t]he applicants (TSPs) are required to submit an undertaking and also enter into an Frequency Agreement (proformas enclosed herewith), dully filled in, before their request for the allotment of MWA/ MWB carriers is considered'* and '*[i]n the event of decision of the Government to allot MWA carrier/ spectrum by auction, the carriers allocated as an interim measure, will stand reverted back to the Government after a period of three months from date of finalization of results of aforesaid auction, in case such allottees fail to participate and/ or win back the carriers/ spectrum provisionally allotted as an interim measure.'*

2.52 In view of the foregoing discussion, the issue arises as to what should be the methodology for assignment of (i) MWB carriers and (ii) MWA carriers for different types of user categories. The stakeholders are requested to provide their comments on the following questions.

Issues for consultation

Q10. Which methodology should be used for assignment of MWA carriers? Response may be provided in the table given below:

User category	**Assignment methodology** [Auction/ Administrative/ Any other (please specify)]	**Justification**
(i) TSPs with Access Service License/ Authorization		
(ii) TSPs with other than Access Service License/ authorization		
(iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use)		

Q11. In case you are of the opinion that certain user categories should be assigned MWA carrier P2P links by any methodology other than auction, should some MWA carriers be earmarked for such users? If yes, how many carriers should be earmarked for each of such user category? Kindly justify your response.

Q12. Which methodology should be used for assignment of MWB carriers? The response may be provided in the table given below:

User category	Assignment methodology [Auction/ Administrative/ Any other (please specify)]	Justification
(i) TSPs with Access Service License/ Authorization		
(ii) TSPs with other than Access Service License/ Authorization		
(iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use)		

Q13. In case you are of the opinion that certain user categories should be assigned MWB carrier by any methodology other than auction, should some MWB carriers be earmarked for such users? If yes, how many carriers should be earmarked for such users? Kindly justify your response.

Q14. In case it is decided to assign MWA/MWB carriers to the TSPs with Access Service License/ Authorization through auction and to continue the existing P2P assignment of MWA/MWB carriers for TSPs other than Access Service License/ Authorization, who may be requiring to establish only a few links, what threshold limit in terms of number of links, may be prescribed, beyond which, the TSPs with other than Access Service License/ Authorization should also be required to acquire MWA/ MWB carriers through auction? Kindly justify your response.

Q15. In case it is decided to assign MWA/ MWB carriers to all types of licensed TSPs through auction, should such TSPs be permitted to lease their spectrum acquired through auction, on P2P link basis, to other TSPs and other entities (non-TSP, for non-commercial/ captive/ isolated use) who may be requiring establishing only a few links? If yes,

(a) suggest a mechanism and regulatory framework for such leasing arrangement.

(b) Do you foresee any regulatory issues and potential misuse of such a regime? If yes, what measures could be put in place to mitigate the concerns?

Kindly justify your response.

Q16. In case MWA/MWB carriers are decided to be assigned through auction,

(a) Should the auction be conducted based on Simultaneous Multiple Rounds Ascending Auction (SMRA) method as adopted for IMT spectrum auction? Any other auction method may be suggested with detailed justification.

(b) what quantum of spectrum in each band (6/7/13/15/18/21 GHz) should be put to auction? Kindly justify your response.

(e) Validity Period

2.53 As already mentioned, presently frequency assignments and re-assignments for MWA/MWB carriers to TSPs having access service license/ authorization, are being considered administratively on a provisional basis as per guidelines dated 16.10.2015 and its addendum dated 25.07.2022. As per current practice, the MWA/MWB spectrum assignments to TSPs are co-terminus with the service license. For TSPs other than access service license/ authorization and other

entities (non-TSP/ non-commercial isolated/ captive users), spectrum assignment is on a P2P link basis, for which formula-based charges are payable on an annual basis.

2.54 As per a report by GSMA and ABI Research on 'Wireless Backhaul Evolution-Delivering next-generation connectivity' of February 2021, ABI Research conducted an analysis of the license types and license durations of the 40 countries. Accordingly, information on license duration has been summarized as per figure given below:

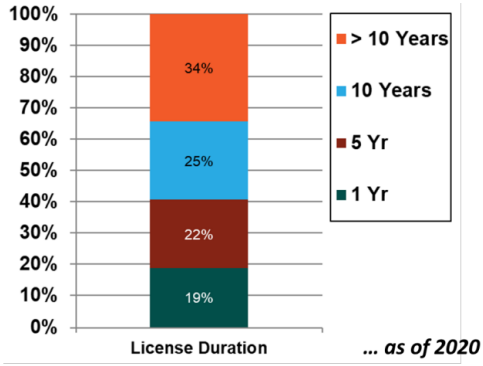

Figure 2.7: Summary of License Duration adopted by surveyed 40 countries, Source: GSMA and ABI Research

2.55 As per the above-mentioned report, 10- or >10-Year licenses are the most common license duration types across the surveyed countries in 2020; accounting for 59% of the licenses surveyed. These licenses are typically sold to operators with ongoing renewals to protect their capital investment in their respective network infrastructure. GSMA report also highlights that the long durations give incumbents extended monopolies over important portions of spectrum and this would give them undue leverage on a share of returns from new use cases, which could serve as an obstacle to innovation. GSMA report also mentions that the short licenses (for one year) allow operators more flexibility in their network planning, as they are not tied down to frequency bands for a long time and this allows for quicker network development, as they can quickly move their links to different bands that have more available spectrum.

2.56 From the preparatory discussion held with the stakeholders, it is understood that the TSPs keep augmenting and surrendering the carriers as per their requirement. In case it is decided to assign MWA and MWB carriers through auction, it needs deliberation as to what should be the period for which spectrum should be assigned through auction i.e., the validity period. One may contend that the validity period could be kept same as that for access spectrum i.e., 20 years. Contrary view could be that considering the future uses of spectrum in these bands, a reasonable but shorter validity period, say 10 years, may be appropriate. Further, since MWA and MWB carriers are generally used where fiber has not yet been deployed and as the rollout of newer cellular technologies will increase, the TSPs may decide to fiberize their network, which may lead to a need for surrender of MWA/ MWB carriers. For access spectrum acquired through auction held in 2022, there is a provision for surrender of spectrum after a lock-in period of 10 years. In case a provision for surrender of MWA and MWB carriers is created, there may be a need to prescribe some lock-in period and other terms and conditions may also have to be prescribed.

2.57 In view of the foregoing discussion, the stakeholders are requested to provide their comments to the following questions.

Issues for Consultation

Q17. In case it is decided to assign MWA and MWB carriers through auction,

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

(b) Whether there is a need to create a provision for surrender of MWA / MWB carriers? If yes, what should be the lock-in period and other associated terms and conditions?

Response may be given for each user category viz. (i) TSPs with Access Service License/ Authorization, (ii) TSPs with other than Access Service License/ Authorization, and (iii) Other entities (non-

TSP, for non-commercial/ captive/ isolated use) with detailed justification.

Q18. In case it is decided to continue with the existing methodology of assignment of MWA/ MWB carriers, whether any change in the validity period, or process for augmentation/ surrender of carriers is required to be made? If yes, suggestions may be made with detailed justification.

(f) Eligibility Conditions and Roll Out Obligations

2.58 As per the existing framework, and as discussed earlier as well, MWA carriers are assigned exclusively to the TSPs with Access Service License/ Authorization on LSA basis, and for TSPs with other than Access Service License/ Authorization and other entities (non-TSP isolated captive users), assignments are made on point-to-point basis. As regards MWB carriers, the carriers are assigned on point-to-point basis to all types of entities.

2.59 It needs to be deliberated that in case it is decided to assign the MWA/ MWB carriers exclusively on LSA basis through auction, which all types of licensees/authorization holders/other entities, should be eligible to participation in the auction. Further, it needs to be deliberated as to whether any other eligibility conditions such as minimum net worth, etc. should be prescribed.

2.60 Further, in case it is decided to assign MWA/ MWB carriers exclusively to the TSPs with Access Service License/ Authorization on LSA basis and to other TSPs/ non-TSPs, there may be a need to ensure that the spectrum assigned is put to use in a timely and efficient manner, there may be a need to prescribe some roll out obligations.

2.61 In view of the foregoing discussion, the stakeholders are requested to provide their comments to the following questions.

Issues for Consultation

Q19. What should be the eligibility conditions and associated conditions for assignment of spectrum in 6/ 7/ 13/ 15/ 18/ 21 GHz bands? Response may kindly be given for each user category viz. (i) TSPs with Access Service License/ Authorization, (ii) TSPs with other than Access Service License/ Authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) with detailed justification.

Q20. Whether there is a need to prescribe any roll out obligations for MWA/ MWB carrier assignment? Should the roll out obligations be linked to the number of carriers assigned to a TSP? Kindly justify your response.

Q21. In case it is decided to prescribe roll out conditions, what should be the roll-out obligations associated with the assignment of spectrum in 6/ 7/ 13/ 15/ 18/ 21 GHz bands? What provisions should be prescribed for non-fulfilment of the prescribed roll-out obligations? Response may kindly be given for each user category viz. (i) TSPs with Access Service License/ Authorization, (ii) TSPs with other than Access Service License/ Authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) with detailed justification.

Q22. Any other suggestions relevant to assignment of spectrum for MWA and MWB in 6/ 7/ 13/ 15/ 18/ 21 GHz frequency bands, may kindly be made with detailed justification.

2.62 The following chapter examines the issues relating to assignment of spectrum in E-band and V-band.

CHAPTER III: EXAMINATION OF ISSUES RELATED TO ASSIGNMENT OF SPECTRUM IN E-BAND AND V-BAND

A. Background

3.1 The backhaul networks' requirements are impacted by the technological advancements in mobile access networks. With the increase in mobile capacity and coverage owing to technological advancements and increasing digitalization, backhaul networks need to fulfill these requirements. This necessitates efficient use of the available spectrum and use of high-capacity backhaul spectrum.

3.2 Millimeter Wave (MMW) using E-Band and V-Band is a technology for high speed (~10 Gbps) high-capacity wireless links, ideal for urban areas. Using high frequency microwave in the E-Band (70-80 GHz) and V-band (57-64 GHz) spectrum, links can be densely deployed in congested cities without interference, and without need for digging for cables and fibre optics, which can be costly, slow and highly disruptive.

E band (71-76 / 81-86 GHz)

3.3 E-band frequencies are point-to-point, line of sight, radio waves in the frequency range of 71-76 GHz paired with 81-86 GHz. The unique transmission properties of very high frequency millimeter-waves enable much simpler frequency coordination, interference mitigation and path planning compared to lower frequency bands. The antennas used in E-band frequencies are highly directional. Together with the propagation limitations, wireless systems operating at the E-band frequencies are highly focused, point-to-point "pencil beam" links allowing a much higher reuse of the same frequency in a given area. These millimeter-waves can support more capacity per backhaul link at a comparatively lower cost to meet broadband demand.

3.4 As per ETSI White Paper[14] on 'E-Band – Survey in Status of Worldwide Regulation' released in September 2020, E-Band characteristics can cover the most popular 5G use cases, requiring high capacity over relatively short hops (densification) up to 2 km. It further mentions that E-Band is a fundamental component of the "Band and Carrier Aggregation" (BCA) approach to satisfy use cases for up to 20 Gbps up to 10 km.

3.5 As per a report on 'Wireless Backhaul Evolution-Delivering next-generation connectivity' of February 2021 by GSMA and ABI Research, the continued use of wireless backhaul will require an evolution toward higher frequency bands, which can support wider channels and have a greater total amount of spectrum available. The E-band (70/80 GHz) will be important across all regions and is expected to enjoy exceptional growth with 11.6% CAGR from 2021 to 2027.

3.6 As per Ericsson Microwave Outlook Report 2022[15], E-band transceivers account for 6% of the globally installed base. In 2027, E-band (70/80 GHz) will account for 25 percent of new deployments, both as standalone and in multi-band solutions. The Report mentions as below:

"With this significant movement in India, as well as uptake in multiple other countries around the globe, we therefore estimate that the previous prediction of a global new deployment share of 20 percent by 2025 is still within reach and that it will continue to grow to 25 percent by 2027. This 25 percent will be a combination of links using E-band as standalone and E-band in multi-band configurations."

[14] https://www.etsi.org/images/files/ETSIWhitePapers/etsi-WP-37-E-Band-survey-on-Status-of-Worldwide-Regulation.pdf

[15] https://www.ericsson.com/4a81b8/assets/local/reports-papers/microwave-outlook/2022/ericsson-microwave-outlook-report-2022.pdf

V band (57-64 GHz)

3.7 The V-band (57-64 GHz) is also used for high-capacity terrestrial millimeter wave communications systems. In addition to the high-data rates that can be accomplished in this spectrum, energy propagation in the 60 GHz band has unique characteristics that make possible many other benefits such as excellent immunity to interference, high security, and frequency re-use. The antennas used in V-band frequencies are also highly directional and together with the propagation limitations, wireless systems operating at the V-band frequencies are also highly focused, point-to-point "pencil beam" links allowing a much higher reuse of the same frequency in a given area.

3.8 Availability of large 7 GHz bandwidth in 60 GHz band, also known as V-Band, makes it suitable for very high capacity (e.g., 100Mbps ~ 1Gbps Ethernet systems) and short hop (1–2 Kms) fixed wireless systems. The 60 GHz band has unique propagation characteristics with high oxygen gas absorption of 15dB/km – i.e., the radiation from a particular radio transmitter is quickly reduced. Though this limits the distances that 60 GHz links can cover, it makes these links highly immune to interference from other 60 GHz radios.

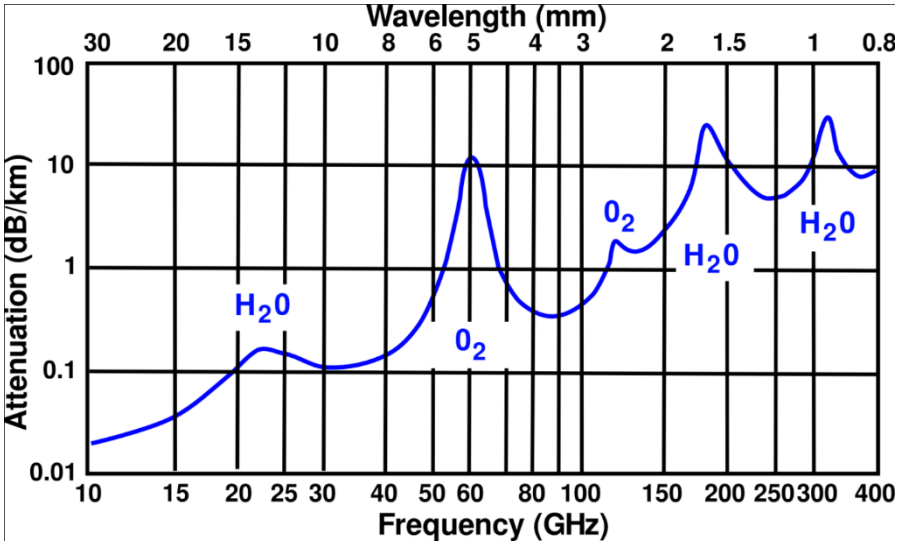

Figure 3.1: Attenuation of signals due to rain or oxygen absorption, Source: 6gworld[16]

3.9 Deployment-related details of E-band and V-band provided in Chapter II of this Consultation Paper may kindly be referred to. As can be seen from figure 2.2 of this CP, while E-band is being adopted at a fast pace, V-band does not seem to show any significant deployment for backhaul purposes. One reason for this could be the availability of a well-developed ecosystem in E-band.

B. TRAI's earlier recommendations on E-band and V-band

3.10 In 2014, TRAI gave its recommendations on '*Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers*' dated 29.08.2014, wherein recommendations on E-band and V-band were also made. On some of the issues, DoT sought clarification/ reconsideration on TRAI's recommendations through back reference dated 16.10.2015. TRAI gave its response to the back-reference on 17.11.2015. Some of the key recommendations related to E-band and V-band, made through the original recommendations and response to back-reference, are reproduced below:

- *In order to increase broadband penetration in India, the usage of high capacity backhaul E-band (71-76 / 81-86 GHz) and V-band (57-64MHz) may be explored for allocation to the telecom service providers.*
- *Both E-band and V-band should be opened with 'light touch regulation' and allotment should be on a 'link to link basis'. The responsibility for registration and database management should lie with WPC wing of DoT. For this purpose, WPC should make necessary arrangements for an online registration process by developing a suitable web portal. Responsibility for interference analysis should rest with the licensee, who needs to check the WPC link database prior to link registration (links should be protected on a "first come, first served" basis). WPC can also maintain a waiting list for the same spot.*

[16] https://www.6gworld.com/exclusives/guest-editorial-a-reality-check-on-ris-and-thz-communications/

- *Channel bandwidth for E-band (71-76 GHz and 81-86 GHz) should be 250MHz with a guard band of 125MHz at the top and bottom of each 5 GHz band. More than one channel can be allowed and allocated for aggregation.*
- *Channel bandwidth for V-band (57-64 GHz) should be 50MHz with a 100MHz guard band at the beginning of the band. More than one channel can be allowed and allocated for aggregation.*
- *E-band carrier should be charged at Rs. 10,000/- (Rs. Ten Thousand) per annum per carrier of 250 MHz each. More than one channel can be allocated and allowed for aggregation. There should be initial promotional discount of 50% for three years from the date of allocation of first carrier in this band.*
- *In case of charging of V-band carriers since there are limitations in this band due to the factors enumerated in para 4.278, it should be charged for Rs. 1000 (Rs. One Thousand) per annum per carrier of 50MHz each. More than one channel can be allocated and allowed for aggregation. There should be initial promotional discount of 50% for three years from the date of allocation of first carrier in this band.*
- *To avoid spectrum hoarding which may be possible by the low fee structure, a rollout obligation should be attached to the licenses and a 12 month time limit for achieving the rollout goal may be given to the licensee failing which the spectrum for that particular spot may be taken back and assigned to next in the waiting list.*
- *The prices mentioned for E-band and V-band has to be reviewed after 5 years based on deployment and usage of the links.*
- *V-band (57-64GHz) should be delicensed for indoor and outdoor based access applications like WiFi hotspots etc.*

C. Examination of issues relating to assignment of spectrum in E-band and V-band

3.11 DoT through its reference dated 12.08.2022, in regard to the E-band and V-band requested TRAI to provide its recommendations, inter-alia, on the following points:

(a) Applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/usages, spectrum cap, payment terms, eligibility conditions, methodology of auction and other associated conditions for auction of E band spectrum for establishment of terrestrial and/ or satellite-based telecom networks.

(b) Applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/usages, spectrum cap, payment terms, eligibility conditions methodology of auction and other associated conditions for auction of V band spectrum for establishment of terrestrial and/ or satellite-based telecom networks.

(c) Quantum of spectrum to be earmarked for non-commercial/ captive/isolated use in E and V bands; and methodology of assignment, where auction is not feasible and pricing for the same.

(d) Feasibility, including technical parameters, for allowing low power, indoor, consumer device-to-consumer device usages on license-exempt basis, in parallel to use of the auction acquired spectrum by telecom service providers for establishment of terrestrial and/ or satellite-based telecom networks, in part or full V band.

3.12 In addition, DoT through its letter dated 11.10.2022 has also requested TRAI to assess the demand of captive usages through the consultation process.

(a) Bands and quantum of spectrum

3.13 As per the information provided by DoT, details of E-band and V-band are given below:

Band	Frequency range
E-band	71-76/81-86 GHz
V-band	57-64 GHz

Table 3.1: Details of E-band and V-band

3.14 DoT through its letter dated 11.10.2022 has informed that *as both of E & V bands are to be assigned on LSA/ pan India basis, hence, auction of these spectrum bands on LSA basis is feasible and therefore, such spectrum may be assigned through competitive bidding/ auction in accordance with opinion of Ld. AG*. DoT has also mentioned that *the recent 3GPP Release-17 dated 12th December 2020 envisage use of 52.6-71 GHz (which include V-band- 57-64 GHz under consideration in India) for 5G terrestrial networks. It also uses this band for Integrated Access and Backbone (IAB).*

3.15 Regarding extending the current NR operation to 71 GHz, 3GPP in its Technical Report[17] noted that:

"RAN carried out a Rel-16 study on NR beyond 52.6 GHz (FS_NR_beyond_52GHz) with corresponding TR in 38.807. From this study, it became apparent the global availability of bands in the 52.6 GHz to 71 GHz range, most notably in the form of the original 60 GHz band (57-66 GHz) and extended 60 GHz band (57-71 GHz). Moreover, WRC19 recently identified the 66-71 GHz frequency range for IMT operation in certain regions.

The proximity of this frequency range (57-71 GHz) to FR2 and the imminent commercial opportunities for high data rate communications makes it compelling for 3GPP to address NR operation in this frequency regime.

To minimize the specification burden and maximize the leverage of FR2 based implementations, 3GPP has decided to extend FR2 operation up to 71 GHz

[17] 3GPP TR 21.917 V17.0.1 (2023-01)

with the adoption of one or more new numerologies (i.e., larger subcarrier spacings). Those new numerologies were identified in the study on waveform for NR>52.6 GHz in the first half of 2020. NR-U defined procedures for operation in unlicensed spectrum were also leveraged towards operation in the unlicensed 60 GHz band."

3.16 Thus, it can be inferred that out of the entire range from 52.6-71 GHz, ITU has so far identified only 66-71 GHz for IMT, which is not part of the V-band range mentioned under the reference by DoT.

3.17 Further, DoT in its reference dated 12.08.2022 has mentioned that while the spectrum in E and V bands should be assigned through auction for provisioning of commercial telecom services; there may be certain non-TSP/ non-commercial usages like captive/individual point-to-point/multipoint usages, which also need spectrum in these bands and where auction may not feasible. For such usages, DoT has requested to (i) assess demand through the consultation paper, and (ii) provide recommendations on the quantum of spectrum to be earmarked for non-commercial/ captive/isolated use in E and V bands; and the methodology of assignment, where auction is not feasible and pricing for the same.

3.18 Currently, 2 carriers (paired) each of 250 MHz in E-band have been assigned to the wireless access service providers as an interim measure for backhaul use on a provisional basis. As regards V-band, no assignments have been made so far. However, there may be need for E-band and V-band backhaul spectrum by other TSPs as well. Thus, the issue arises as to which all types of TSPs would be requiring backhaul spectrum in E-band and V-band and how much quantum is required.

3.19 In view of the above, the stakeholders are requested to provide their comments to the following issues:

Issue for Consultation

Q23. What quantum of spectrum in E-band (71-76 / 81-86 GHz) and V-band (57-64 GHz) is required to meet the demand of TSPs with Access Service License/ Authorization? Whether spectrum in E-band and V-band is also required by the TSPs other than Access Service License/ Authorizations, and other entities (non-TSP, for non-commercial/ captive/ isolated use)? Information on present demand and likely demand after five years may kindly be provided as per the proforma given below:

(i) Present demand

Band	**Quantum of spectrum required (per entity per LSA)**		
	TSPs with Access Service License/ Authorization	**TSPs with other than Access Service License/ Authorization**	**Other entities (non-TSP, for non-commercial/ captive/ isolated use)**
E-band (71-76/81-86 GHz)			
V-band (57-64 GHz)			

(ii) Likely demand after five years

Band	Quantum of spectrum required (per entity per LSA) -		
	TSPs with Access Service License/ Authorization	TSPs with other than Access Service License/ Authorization	Other entities (non-TSP, for non-commercial/ captive/ isolated use)
E-band (71-76/81-86 GHz)			
V-band (57-64 GHz)			

Q24. Whether spectrum in E-band and V-band should be assigned exclusively on an LSA-basis, or on P2P link basis? Response may be provided separately for (i) TSPs with Access Service License/ Authorization, (ii) TSPs other than Access Service License/ Authorization, and (iii) other users (non-TSP, for non-commercial/ captive/ isolated use) in the table given below with detailed justification.

Microwave bands	Spectrum should be assigned for the entire LSA on exclusive basis, or on P2P link basis for -		
	TSPs with Access Service License/ Authorization	TSPs with other than Access Service License/ Authorization	other entities (non-TSP, for non-commercial/ captive/ isolated use)
E-band (71-76/81-86 GHz)			
V-band (57-64 GHz)			

(b) E-band and V-band for satellite-based communication network

3.20 DoT through its reference letter dated 12.08.2022 has requested TRAI to provide its recommendations for auction of E-band and V-band for establishment of terrestrial and/ or satellite-based telecom networks.

3.21 As per the National Frequency Allocation Plan 2022[18], the spectrum frequency in E-band (71-76/ 81-86 GHz) has been allocated to the following services:

71-74 GHz	**74-76 GHz**
FIXED FIXED-SATELLITE (space-to-Earth) MOBILE MOBILE-SATELLITE (space-to-Earth) IND 34[19]	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE BROADCASTING BROADCASTING-SATELLITE Space research (space-to-Earth) 5.561[20] IND 34

81-84 GHz	**84-86 GHz**
FIXED 5.338A FIXED-SATELLITE (Earth-to-space) MOBILE MOBILE-SATELLITE (Earth-to-space) RADIO ASTRONOMY Space research (space-to-Earth) 5.149 5.561A IND 34	FIXED 5.338A FIXED-SATELLITE (Earth-to-space) MOBILE RADIO ASTRONOMY 5.149 IND 34

Table 3.2: Allocations in E-band as per NFAP

3.22 Thus, a variety of services including fixed, fixed-satellite (space-to-Earth/ Earth-to-space), mobile, mobile-satellite (space-to-Earth/ Earth-to-space),

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

[19] IND 34: The band 71-76 GHz and 81-86 GHz may be used for high-density point to point / multipoint links in Fixed Service (FS) also taking care of FSS service.

[20] 5.561: In the band 74-76 GHz, stations in the fixed, mobile and broadcasting services shall not cause harmful interference to stations of the fixed-satellite service or stations of the broadcasting-satellite service operating in accordance with the decisions of the appropriate frequency assignment planning conference for the broadcasting satellite service. (WRC-2000)

broadcasting, broadcasting-satellite have been allocated on a primary basis in portions of the bands 71-76 GHz, 81-86 GHz bands. According to IND 34 Footnote, frequency bands 71-76 GHz and 81-86 GHz can be used for high density point to point/ multipoint links in fixed service (FS) also by taking care of FSS (fixed satellite service).

3.23 In the Resolution 775[21] of WRC-19[22], *'Sharing between stations in the fixed service and satellite services in the frequency bands 71-76 GHz and 81-86 GHz'*, ITU[23] has resolved to conduct, as a matter of urgency and in time for WRC-27, *the appropriate studies to determine power flux-density and equivalent isotropically radiated power limits in Article 21 for satellite services to protect the fixed service in the frequency bands 71-76 GHz and 81-86 GHz without* unduly *constraining satellite systems.* The same has been incorporated under the preliminary Agenda Item 2.4 of WRC-27[24] for the introduction of power flux-density (pfd) and equivalent isotropically radiated power (e.i.r.p.) limits in Article 21 for the frequency bands 71-76 GHz and 81-86 GHz in accordance with Resolution 775 (WRC-19)

3.24 In the Resolution 178[25] of WRC-19, *'Studies of technical and operational issues and regulatory provisions for non-geostationary fixed-satellite service satellite system feeder links in the frequency bands 71-76 GHz (space-to-Earth and proposed new Earth-to-space) and 81-86 GHz (Earth-to-space)'*, it has been resolved to conduct, and complete following studies in time for WRC-27:

> *'1. studies considering additional spectrum needs for the development of non-GSO FSS satellite systems in the frequency bands 71-76 GHz and 81-86 GHz, the technical conditions for their use, and the*

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

[22] WRC-19: World Radio Congress, 2019

[23] ITU: International Telecommunications Union

[24] https://www.itu.int/en/ITU-R/study-groups/rcpm/Pages/wrc-27-preliminary-studies.aspx

[25] https://www.itu.int/dms_pub/itu-r/oth/0C/0A/R0C0A00000F0065PDFE.pdf

possibility of optimizing the use of these frequency bands with a view to increasing spectrum efficiency;

2. studies of technical and operational issues for the operation of feeder links for non-GSO FSS satellite systems in the frequency bands 71-76 GHz (space-to-Earth and the feasibility of a possible new allocation for reverse-band feeder operation in the Earth-to-space direction) and 81-86 GHz (Earth-to-space), as well as consideration of regulatory provisions in some or all of these frequency bands for non-GSO systems coordinating and sharing with both GSO and other non-GSO systems in the FSS, MSS and BSS, and their specific earth stations, taking into account the future growth of these uses and the need to ensure their protection;

3. sharing and compatibility studies between non-GSO FSS satellite system feeder links in the frequency bands 71-76 GHz (space-to-Earth and a possible new allocation for non-GSO FSS in the Earth-to-space direction) and 81-86 GHz (Earth-to-space) and other existing co-primary services, including the fixed and mobile services, in those frequency bands and in adjacent frequency bands, taking into account the need to ensure the protection of these services;

4. studies of possible necessary provisions of the Radio Regulations to ensure protection of the EESS (passive) and SRS (passive) in the frequency band 86-92 GHz from non-GSO FSS transmissions, including study of aggregate FSS interference;

5. studies towards ensuring protection of the RAS operating in the frequency bands 76-86 GHz and 86-92 GHz from non-GSO FSS transmissions, taking into account above, including study of aggregate FSS interference effects from networks and systems operating or planned to operate in the frequency bands described in 2 above.'

The results of the above studies will be considered in the WRC-27.

3.25 From the above, it can be inferred that ITU is conducting studies for sharing/ coexistence of satellite system feeder links and Fixed services in E-band. Moreover, DoT through a separate reference has sought TRAI's recommendations for auction of spectrum for space-based communication services. In this regard, a consultation paper on 'Assignment of Spectrum for Space-based Communication Services' has been released by TRAI on 06.04.2023.

3.26 In the article 'Using E-Band for Wideband Satcom: Opportunities and Challenges'[26], it is mentioned that E-Band satellite communication is becoming more suitable due to the growing demand for users to connect to the internet at higher data rates, which requires higher data capacity from commercial very high throughput satellite (VHTS) systems. E-Band is the logical next band for feeder links after V-Band and is attractive because of the available bandwidth. At these higher frequencies, antennas create highly directive pencil beams that provide high gain, to compensate for high path loss, and high discrimination, enabling gateways to be tightly packed into favorable rain zones without suffering from co-frequency interference.

3.27 Considering that '*the appropriate studies to determine power flux-density and equivalent isotropically radiated power limits in Article 21 for satellite services to protect the fixed service in the frequency bands 71-76 GHz and 81-86 GHz without unduly constraining satellite systems'* has been incorporated under the preliminary Agenda Item 2.4 of WRC-27[27] for the introduction of power flux-density (pfd) and equivalent isotropically radiated power (e.i.r.p.) limits in Article 21 for the frequency bands 71-76 GHz and 81-86 GHz in accordance with Resolution 775 (WRC-19), one may contend that it may be appropriate to consider E-band band spectrum for satellite-based communication network at a later date, in accordance with the outcome of WRC-27.

[26] https://www.microwavejournal.com/articles/36514-using-e-band-for-wideband-satcom-opportunities-and-challenges

[27] https://www.itu.int/en/ITU-R/study-groups/rcpm/Pages/wrc-27-preliminary-studies.aspx

3.28 As regards V-band frequency range from 57 GHz to 64 GHz, as per NFAP 2022, this frequency range has not been allocated for commercial satellite communication services to be provided on the Earth's Surface. Thus, prima facie, there may not be a case of satellite-based telecom networks in the frequency range mentioned by DoT in its reference, as of now.

3.29 In view of the above, the stakeholders are requested to provide their comments to the following issues:

Issues for Consultation

Q25. Do you agree that the issues relating to the assignment of E-band and V-band for space-based communication services and its coexistence with terrestrial networks may be taken up at a later date? If not, the concerns and measures to overcome such concerns may kindly be suggested with relevant details.

(c) Band plan and Carrier size

3.30 For E-band, ITU-R Recommendation F.2006[28] (03/2012) recommended several combinations with channel bandwidth with guard band of 125 MHz at the top and bottom of each 5 GHz band. There are 19 channels of 250 MHz each with a duplex separation of 10 GHz between them along with separation between the blocks by 5 GHz. In addition, channel plan with duplex spacing of 2.5 GHz option has also been recommended. ITU recommendations give flexibility to the administration to decide about deployment in TDD, FDD or their mixed use of the band. Thus, both FDD and TDD configuration arrangements are possible. However, globally, FDD configuration with duplex separation of 10 GHz has been adopted. The temporary assignments made in India, have also been made with FDD configuration.

[28] https://www.itu.int/dms_pubrec/itu-r/rec/f/R-REC-F.2006-0-201203-I!!PDF-E.pdf

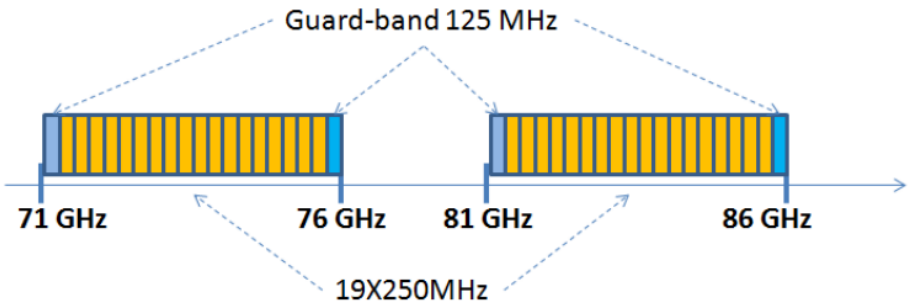

Figure 3.2: Channel plan of E-band

3.31 In regard to V-band (57-64 GHz)[29] the Slot arrangement defined by ITU is in multiples of 50 MHz. The initial two slots are reserved as guard bands and any channel size can be defined in multiples of 50 MHz. In total 140 slots of 50 MHz are there, 2 reserved as guard band, 138 slots of 50 MHz each are available for assignment.

Bands limits (GHz) →	57-59							59-63					63-64		
50 MHz Slot number	1	2	3	4	.....	39	40	41	42	.....	119	120	121	.....	140
	Guard Band				.....					.....				.....	

Figure 3.3: Channel plan of V-band

3.32 As per the ITU Recommendation, channels n = 1, 2 may be considered as guard-band (GB) towards lower band 55.78-57 GHz, possibly subject to different coordination conditions; in this case they should only be used for temporary purposes or equipment alignment and propagation tests. In the upper band edge, there is no need for guard band because the same system might appropriately operate also in the adjacent 64-66 GHz band. ITU recommendations provide that either TDD or FDD, may be derived by basic

[29] RECOMMENDATION ITU-R F.1497-2 - Radio-frequency channel arrangements for fixed wireless systems operating in the band 55.78-66 GHz

channels aggregation. FDD duplex separation has not been specifically identified and left free for definition at national level according to the needs.

3.33 The report by GSMA and ABI research on 'Wireless Backhaul Evolution - Delivering next-generation connectivity' of February 2021 provides a table depicting typical channel size in microwave bands. Figure given below shows the typical Channel Sizes, Data Throughput in traditional microwave bands, as published in the report.

Main Backhaul Bands	Typical Channel Sizes in 2020 (MHz)	Data Throughput (GBps)	Typical Channel Sizes in 2027 (MHz)	Data Throughput (GBps)
V-Band (57-70 GHz)	100		2160	> 4.0
E-Band (71 - 86 GHz)	500	3.2	500	3.2
	1000	6.4	1000	6.4
			2000	12.8

Figure 3.4: Typical Channel Sizes and Data Throughput in E and V bands

3.34 DoT, in view of increased backhaul capacity requirements of TSPs with Access Service License/ Authorization and having Access Spectrum in the IMT bands, especially on account of 5G, decided to allot carriers in E-band spectrum for the purpose of backhaul on interim basis. For this, DoT issued guidelines for allotment of E-band (71-76/ 81-86 GHz) carriers on 25.07.2022 (copy enclosed as **Annexure 3.1**). According to these guidelines:

(1) TSPs would be allotted a maximum of two carriers of 250 MHz each (paired) bandwidth in E-band (71-76/ 81-86) GHz for their backhaul purpose in the LSAs where they are holding Access Spectrum in IMT bands.

(2) All E-band carriers assigned, as an interim measure, will be purely on temporary and provisional basis and all such assignees will have to participate in the auction and/ or any other assignment methodology, as

decided by the Government after considering the TRAI's recommendations.

(3) The E- band carriers, assigned as an interim measure, will stand reverted back to the Government, after a period of three months from the date of finalization of results in case such assignees fail to get back the carriers/ spectrum provisionally assigned as an interim measure.

(4) Any misuse, i.e., use of E-band carriers allotted for purpose(s) other than backhaul will lead to immediate withdrawal of these carriers and invocation of relevant terms and conditions of the UL/ UASL-Access Service Authorization.

3.35 So far, E-band carriers have been assigned to 2 TSPs and both have taken 500 MHz paired spectrum [2 carriers of 250 MHz (paired)]. V-band has not been assigned so far in India. As shown by the above figure, typical channel size for E-band is 500/1000 MHz and for V-band it is 100 MHz. While larger channel size prevents fragmentation of spectrum, smaller channel size provides flexibility to the TSPs. The question arises is what should be the carrier size for assignment of spectrum in E-band and V-band.

3.36 As already mentioned, DoT is presently assigning E-band carriers on a temporary and provisional basis with certain terms and conditions. Accordingly, the existing licensees holding E-band carriers are required to participate in the auction and/or any other assignment methodology, as decided. Therefore, since the TSPs will have to participate in the new spectrum assignment methodology, there may be a case that a TSP may not be assigned the same frequency carrier. From the preparatory discussion with the OEMs, it is understood that generally E-band equipment support the entire band. However, it needs to be deliberated that whether any change in the existing carrier frequencies is likely to cause any disruption of services to the consumers or some specific measures need to be taken so that a TSP is given a choice to retain the same frequency carrier as long as the TSP is able to acquire the required number of carriers in the new regime.

3.37 In this background, the Authority solicits comments of stakeholders on the following set of questions:

Issues for Consultation

Q26. Whether it will be appropriate to continue with the Frequency Division Duplexing (FDD) based configuration as adopted for the provisional assignment of E-band carriers or Time Division Duplexing (TDD) based configuration should be adopted? Kindly justify your response.

Q27. Whether Frequency Division Duplexing (FDD) or Time Division Duplexing (TDD) based configuration should be adopted for V-band carriers? In case you are of the opinion that FDD based configuration should be adopted, detailed submissions may be made with band plan, ecosystem availability, and international scenario.

Q28. What should be the carrier size for assignment of spectrum in E-band (71-76/81-86 GHz) and V-band (57-64 GHz)? Whether there is a need to prescribe a different carrier size based on different LSA categories or different user categories viz. (i) TSPs with Access Service License/ Authorization, (ii) TSPs other than Access Service License/ Authorization and (iii) other users (non-TSP, for non-commercial/ captive/ isolated use)? If yes, suggestions may be made with detailed justification.

Q29. Whether there is a need to assign spectrum in E-band and V-band in such a way that if a TSP acquires more than one carrier, all the assigned carriers to a TSP are contiguous? Kindly justify your response.

Q30. Since E-band carriers will be reassigned as per the assignment methodology that will be finalized, to avoid any disruption of services to the consumers of the existing TSPs holding E-band carriers, whether there is a need to create a provision such that the TSP is

given a choice to retain the same frequency carrier as long as such TSP is able to acquire the carriers in the new regime? Kindly justify your response.

(d) Maximum number of carriers per Licensee

3.38 As already mentioned in Chapter II of this CP, the objective of prescribing the maximum number of carriers that a Licensee can hold is to prevent large holdings of carriers by one or a few TSPs, which otherwise, may create concerns for the competition in the market.

3.39 As per the DoT guidelines for allotment of E-band (71-76/ 81-86 GHz) carriers dated 25.07.2022 TSPs with Access Service authorization/ license can apply for a maximum of two carriers of 250 MHz each (paired) spectrum in E-band for their backhaul purpose in the LSAs where they are holding Access Spectrum in IMT bands. However, with increasing data traffic, the wireless access service providers may be requiring more than 500 MHz (paired) spectrum in E-band. In addition to wireless access service providers, backhaul spectrum in E-band and V-band may also be required by TSPs other than wireless access service providers.

3.40 Further, as mentioned by DoT in its reference dated 12.08.2022, there may be certain non-TSP/ non-commercial usages like captive/ individual point to point/ multipoint usages, which also need spectrum in these bands, and where auction may not be feasible. Thus, some carriers may have to be earmarked for such users.

3.41 Considering that 19 carriers of 250 MHz (paired) spectrum are available in E-band and 138 carriers of 50 MHz (unpaired) spectrum are available in V-band, the issue arises as to what should be the maximum number of carriers per TSP/ entity in each LSA.

3.42 In view of the foregoing discussion, the stakeholders may provide their comments on the following issues.

Issues for Consultation

Q31. Whether there is a need to prescribe the maximum number of carriers that can be held by a TSP in E-band and V-band? Kindly justify your response.

Q32. In case it is decided to prescribe a ceiling on the number of carriers that a licensee can hold in E-band and V-band,

(a) Whether different ceilings based on the service area category i.e., Metro/ Category 'A' Circles/ Category 'B' Circles/ Category 'C' Circles, need to be prescribed?

(b) Considering a carrier of 250 MHz (paired) spectrum for E-band, and 50 MHz (unpaired) spectrum for V-band, what should be the ceiling in terms of the number of carriers per licensee for each service area category for

(i) TSPs with access service License/ authorization holding IMT spectrum,

(ii) TSPs with access service License/ authorization not holding IMT spectrum, and

(iii) TSPs with other than Access Service License/ Authorization?

(c) Any other relevant suggestion may be made with justification.

(e) Assignment methodology

3.43 As already mentioned, DoT, in view of the increased backhaul capacity requirements of TSPs with Access Service authorization/ license and having Access Spectrum in the IMT bands, especially on account of 5G, decided to allot carriers in E-band spectrum for the purpose of backhaul on interim basis. For this, DoT issued guidelines for allotment of E-band (71-76/ 81-86 GHz) carriers on 25.07.2022[30]. Accordingly, mobile service providers can apply for allotment of a maximum of two carriers of 250 MHz each (paired) bandwidth in E-band (71-76/81-86) GHz for their backhaul purpose in the LSAs where they are holding Access Spectrum in IMT bands. However, such administrative assignment of E-band carriers is temporary and provisional, and all such assignees will have to participate in the auction and/ or any other assignment methodology, as decided by the Government after considering the TRAI's recommendations.

3.44 It is also to note that as per the Guidelines dated 25.07.2022, *'[a]ll E-band carriers assigned, as an interim measure, will be purely on temporary and provisional basis and all such assignees will have to participate in the auction and/or any other assignment methodology, as decided by the Government after considering the recommendations of the TRAI in this regard'* and *'[t]he E- band carriers, assigned as an interim measure, will stand reverted back to the Government, after a period of three months from the date of finalization of results of aforesaid activity as detailed/stipulated in para 5 above in case such assignees fail to get back the carriers/ spectrum provisionally assigned as an interim measure.'*

3.45 DoT in its reference dated 12.08.2022 has mentioned that the matter of E-band and V-band spectrum assignment was deliberated in DoT, and it emerged that

[30] DoT's Guidelines for allotment of E-band (71-76/81-86 GHz) carriers to Telecom Service Providers (TSPs) with Access Service authorization/license and having Access Spectrum in IMT bands dated 25.07.2022.
[https://dot.gov.in/sites/default/files/Guidelines%20for%20allotment%20of%20E-band%20dated%2025%2007%202022%20signed.pdf]

while the spectrum in E and V bands should be assigned through auction for provisioning of commercial telecom services; there may be certain non-TSP/ non-commercial usages like captive/individual point to point/multipoint usages, which also need spectrum in these bands and where auction may not feasible.

3.46 In response to TRAI letter dated 09.09.2022 seeking, *inter-alia*, rationale for arriving at the conclusion that E & V bands should be assigned through auction, DoT through its letter dated 11.10.2022 has mentioned that the large reusability/small link size, dense deployment, makes E & V bands more suitable for LSA wise assignment rather than link by link assignment as the accounting/administration of large number of links in these bands and charging therein is not feasible in Indian context. As both E & V band are to be assigned on LSA/pan India basis, hence, auction of these spectrum bands on LSA basis is feasible and therefore, such spectrum may be assigned through competitive bidding/auction in accordance with opinion of Ld. AG.

3.47 Therefore, the first question arises as to whether spectrum in E-band and V-band should be assigned on LSA basis as defined for Access services Authorization in the Unified License or on pan-India basis. One may contend that since the service license for access services is on LSA basis, spectrum should also be assigned on LSA basis. However, in case spectrum in E-band and V-band is also required by TSPs other than access service providers, the licensed service for such TSPs may not be same as that for access service providers.

3.48 In case spectrum in E and V bands is decided to be assigned exclusively on LSA basis, one may contend that spectrum in E-band and V-band should be assigned through auction. Assignment of spectrum in E & V bands to TSPs other than access service license/ authorization involves similar issues as discussed for MWA in para 2.48 of this CP.

3.49 Further, as mentioned by DoT in its reference dated 12.08.2022, there may be certain non-TSP/ non-commercial usages like captive/ individual point-to-point/ multipoint usages, which also need spectrum in these bands, and where auction

may not be feasible. Such users may require E-band and V-band links to connect the nodes of the network within an isolated geographical area or two or more premises occupied by such user. Further to assign E-band and V-band carriers on P2P links basis to such users by any methodology other than auction, some carriers may have to be earmarked for such users.

3.50 Further, DoT through its reference dated 12.08.2022 has also sought TRAI recommendations on scope of services/ usages for spectrum in E-band and V-band. As per the guidelines issued by DoT for allotment of E-band (71-76/ 81-86 GHz) carriers dated 25.07.2022, E-band carriers are assigned to the TSPs with access service license/authorization for backhaul purpose in the LSAs the TSP is holding Access Spectrum in IMT bands. The guideline further states that:

"Any misuse, i.e. use of E-band carriers allotted for purpose(s) other than backhaul will lead to immediate withdrawal of these carriers and invocation of relevant terms and conditions of the UL/ UASL-Access Service Authorization."

3.51 In this background, the Authority solicits comments of stakeholders on the following set of questions:

Issues for consultation

Q33. Which methodology should be used for assignment of spectrum in E-band and V-band? Response may be provided in the table given below:

User category	**Assignment methodology** [Auction/ Administrative/ Any other (please specify)]	**Justification**
(i) TSPs with Access Service License/ authorization		
(ii) TSPs with other than Access Service License/authorization		

(iii)	**Other entities (non-TSP, for non-commercial/ captive/ isolated use)**		

Q34. In case you are of the opinion that certain user categories should be assigned spectrum in E-band and V-band for P2P links by any methodology other than auction, should some carriers be earmarked for such users? If yes, how many carriers should be earmarked for such users? Kindly justify your response.

Q35. In case it is decided to assign spectrum in E & V bands to the TSPs with Access Service License/ Authorization through auction and adopt P2P links assignment for TSPs other than Access Service License/ Authorization, who may be requiring to establish only a few links, what threshold limit in terms of number of links, may be prescribed, beyond which, the TSPs with other than Access Service License/ Authorization should be required to acquire spectrum in E-band and V-band bands through auction? Kindly justify your response.

Q36. In case it is decided to assign spectrum in E & V bands to all the TSPs through auction, should such TSPs be permitted to lease their spectrum acquired through auction, on P2P link basis, to the TSPs and other entities for non-commercial/ captive/ isolated use, who may be requiring to establish only a few links? What could be the regulatory issues and potential misuse of such a regime? What measures could be put in place to mitigate the concerns? Kindly justify your response.

Q37. In case it is decided to assign spectrum in E-band (71-76/ 81-86 GHz) and V-band (57-64 GHz) on an exclusive basis, should the spectrum be assigned on an LSA basis, or pan-India basis or for any other geographic area should be defined? Kindly justify your response.

Q38. What should be the scope of services/ usages for spectrum in E-band (71-76/ 81-86 GHz) and V-band (57-64 GHz) assigned through auction or any other assignment methodology? Kindly justify your response.

Q39. In case spectrum in E-band and V-band is decided to be assigned through auction,

(a) Should the auction be conducted based on Simultaneous Multiple Rounds Ascending Auction (SMRA) method as adopted for IMT spectrum auction? Any other auction method may be suggested with detailed justification.

(b) What quantum of spectrum in each band should be put to auction? Kindly justify your response.

(f) Validity Period

3.52 As already mentioned, presently, E-band carriers are assigned purely on temporary and provisional basis and all such assignees will have to participate in the auction and/ or any other assignment methodology, as decided by the Government after considering the TRAI's recommendations. Further, the E-band carriers, assigned as an interim measure, will stand reverted back to the Government, after a period of three months from the date of finalization of results in case such assignees fail to get back the carriers/ spectrum provisionally assigned as an interim measure. Thus, it can be inferred that validity period has not been defined for E-band spectrum assigned provisionally. As already mentioned, so far, spectrum in V-band (57-64 GHz) has not been assigned to the TSPs.

3.53 For providing certainty to the TSPs, it may be appropriate to keep a reasonably longer validity period. Backhaul spectrum is used as a substitute for OFC in certain areas, which is a business decision based on several factors already

discussed in chapter-II of this CP. One may contend that since Access spectrum is assigned for a period of 20 years, backhaul spectrum should also be assigned for a period of 20 years. However, as highlighted in the report on 'Wireless Backhaul Evolution-Delivering next-generation connectivity' of February 2021 by GSMA and ABI Research, *the long durations give incumbents extended monopolies over important portions of spectrum; this would give them undue leverage on a share of returns from new use cases, which could serve as an obstacle of innovation*. The Report also mentions that *the short licenses allow operators more flexibility in their network planning, as they are not tied down to frequency bands for a long time; this allows for quicker network development, as they can quickly move their links to different bands that have more available spectrum.*

3.54 In case it is decided to assign spectrum in E-band and V-band through auction, it needs deliberation as to what should be the period for which spectrum should be assigned through auction i.e., the validity period. Further, since backhaul spectrum is used where fiber has not yet been deployed and as the rollout of newer cellular technologies will increase, the TSPs may decide to fiberize their network, thereby surrendering spectrum in E & V bands. For access spectrum acquired through auction held in 2022, there is a provision for surrender of spectrum after a lock-in period of 10 years. In case a provision for surrender of E & V band carriers is created, there may be a need to prescribe some lock-in period and other terms and conditions may also have to be prescribed.

3.55 In view of the foregoing discussion, the stakeholders are requested to provide their comments to the following questions.

Issues for Consultation

Q40. In case it is decided to assign spectrum in E & V bands through auction,

(a) What should be the validity period?

(b) Whether there is a need to create a provision for surrender of E & V band? If yes, what should be the lock-in period and other terms and conditions?

Response may be given for each user category viz. (i) TSPs with Access Service License/ authorization, (ii) TSPs with other than Access Service License/ authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) with detailed justification.

Q41. In case it is decided to assign spectrum in E-band and V-band through any methodology other than auction, what should be the validity period, process for augmentation/ surrender of carriers, and other terms and conditions? Suggestions may be made with detailed justification.

(g) Eligibility Conditions and Roll Out Obligations

3.56 As can be seen from the guidelines for allotment of E-band (71-76/ 81-86 GHz) carriers dated 25.07.2022, the E-band spectrum has been assigned only to the access service providers. However, for the penetration of broadband services and to provide reliable services, high-capacity backhaul spectrum may be required by other telecom service providers such as Internet service providers, etc. along with access service providers.

3.57 It needs to be deliberated that in case it is decided to assign the spectrum in E-band and V-band exclusively through auction, which all types of licensees/authorization holders/other entities, should be eligible to participate in the auction. Further, it needs to be deliberated as to whether any other eligibility conditions such as minimum net worth, holding IMT spectrum, etc. should be prescribed.

3.58 Further, in case it is decided to assign spectrum in E-band and V-band exclusively to the TSPs on LSA basis, there may be a need to ensure that the spectrum assigned is put to use in a timely and efficient manner, there may be a need to prescribe some roll out obligations.

3.59 In view of the foregoing discussion, the stakeholders are requested to provide their comments to the following questions.

Issues for Consultation

Q42. What should be the eligibility conditions and associated conditions for assignment of spectrum in E-band (71-76/81-86 GHz) and V-band (57-64 GHz)? Response may be given for each user category viz. (i) TSPs with Access Service License/ authorization, (ii) TSPs with other than Access Service License/ authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) with detailed justification.

Q43. Whether there is a need to prescribe any roll out obligations for spectrum in E-band and V-band? Should the roll out obligations be linked to the number of carriers assigned to a TSP? Kindly justify your response.

Q44. In case it is decided to prescribe roll out conditions, what should be the roll-out obligations associated with the assignment of spectrum in E-band and V-band? What provisions should be prescribed for non-fulfilment of the prescribed roll-out obligations? Response may kindly be given for each user category viz. (i) TSPs with Access Service

License/ Authorization, (ii) TSPs with other than Access Service License/ Authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) with detailed justification.

(h) Feasibility for allowing low power, indoor, consumer-device-to-device usages on license exempt basis

3.60 DoT through its reference dated 12.08.2022 has mentioned that in V-band the the device/chipset eco-system supporting various technologies for data transfer between consumer's devices such as smartphones, camera, laptops etc. has developed. The technologies used for such devices are designed for short-range, indoor, interference-tolerant applications. Therefore, while the V band spectrum can be assigned through auction for establishment of indoor/outdoor telecom networks, allowing low power, indoor usages of V band on license-exempt basis for consumer-device-to-consumer-device data transfer may go a long way in serving greater public interest and realizing significant socio-economic gains.

3.61 With the above view, DoT has requested TRAI to provide its recommendations on the feasibility, including technical parameters, for allowing low power, indoor, consumer device-to-consumer device usages on license-exempt basis, in parallel to use of the auction acquired spectrum by telecom service providers for establishment of terrestrial and/ or satellite-based telecom networks, in part or full V band.

3.62 ITU in its recommendation on '*Multiple Gigabit Wireless Systems in frequencies around 60 GHz*'[31], provided general characteristics and radio interface standards for Multiple Gigabit Wireless Systems (MGWS) in frequencies around 60 GHz. MGWS radiocommunication networks can be used in short-range, line-of-sight and non-line-of-sight circumstances with traditional WLAN topologies.

[31] ITU-R M.2003-2 (01/2018) [https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2003-2-201801-I!!PDF-E.pdf]

MGWS systems can also be used in very short-range high-rate proximity communications where the radio range is a few centimeters with devices pairing point-to-point in close proximity of each other. Some of the key points of ITU Recommendations are given below:

- For WLAN, total communication range and performance will vary depending on system design (e.g. number of antenna elements) as well as the environment, but multiple gigabit performance is typically expected at ranges around 10 m for in-room use when devices typically possess a few (≤ 3) dozen antenna elements, to a few hundred meters for outdoor use when devices can be equipped with several (≥ 6) dozen antenna elements.

- For close proximity communication, performance up to 100 Gbps is expected with range of 10 cm or less (devices nearly touching) with transient connections (rapid setup and teardown); Close proximity devise typically will use a single antenna element and very low transmit power.

- Regarding the spectrum, a minimum of 7 GHz contiguous spectrum in the 57-71 GHz is needed to satisfy the requirements of the applications envisioned to be used in this spectrum. This would allow up to six channels for flexibility and improved connectivity. Furthermore, for single channels, a channel bandwidth of 2160 MHz allows simpler modulation schemes to achieve multi-Gbps data rates, which is suitable for adoption by low power devices such as smartphones, tablets, etc. To achieve greater capacity, single channels are bonded as an integer multiple of 2160 MHz to enable coexistence with 2160 MHz systems.

- It is important that MGWS standards employ the same channelization in order to promote better coexistence. Centre frequencies for single channels are recommended to be at 58.32, 60.48, 62.64, 64.80 GHz, 66.96 GHz, and 69.12 GHz. For bonded channels, centre frequencies

depend on how many single channels are bonded but need to be uniformly spaced with respect to the single channel centre frequencies.

- For Channel access schemes, basic access scheme is time division multiple access (TDMA), which is necessary to deal with the challenges of operation in 60 GHz, the directional nature of communication, and applications such as wireless display. TDMA can provide the necessary bandwidth guarantee to applications sensitive to quality of service. Contention-based access, such as provided by in Wi-Fi, should also be supported for usages including web browsing and file transfer. However, instead of being the basic access scheme, contention-based access should be used within periods of time allocated in the TDMA channel access infrastructure.

- For improved coexistence, it is important that all MGWS utilize the same channelization. For example, channelization of IEEE Std 802.11-20165[32], IEEE Std 802.15.3-20166[33], and IEEE Std 802.15.3e-20177[34] defines a channel bandwidth of 2160 MHz. Further, apart from the above, standards such as ETSI EN 302 567 v2.1.1, Wi-Fi Alliance Protocol Adaptation Layer, ISO/IEC 13156 also address MGWS specifications.

3.63 It can be seen from the above that channel Centre frequencies for single channels recommended by ITU are 58.32 GHz, 60.48 GHz, 62.64 GHz, 64.80 GHz, 66.96 GHz, and 69.12 GHz. Considering that V-band frequency range referred by DoT is 57-64 GHz, first 3 channels of 2.16 GHz each as recommended by ITU for Multiple Gigabit Wireless Systems, as shown below, are under consideration:

[32] IEEE Standard for Telecommunications and Information Exchange Between Systems – Local and Metropolitan Area Networks.

[33] IEEE Standard for High Data Rate Wireless Multi-Media Networks

[34] IEEE Standard for High Data Rate Wireless Multi-Media Networks Amendment: High-Rate Close Proximity Point-to-Point Communications.

Channel	Start frequency (GHz)	End frequency (GHz)	Centre Frequency (GHz)
1	57.24	59.40	58.32
2	59.4	61.56	60.48
3	61.56	63.72	62.64

3.64 As already mentioned, DoT has sought TRAI recommendations on feasibility, including technical parameters, for allowing low power, indoor, consumer device-to-consumer device usages on license-exempt basis, in parallel to use of the auction acquired spectrum by telecom service providers for establishment of terrestrial and/ or satellite-based telecom networks, in part or full V band.

3.65 In view of the foregoing discussion, the stakeholders are requested to provide their comments to the following questions.

Issues for Consultation

Q45. Whether it is feasible to allow low powered indoor consumer device-to-consumer device usages on license-exempt basis in V-band (57-64 GHz), in parallel to use of the auction acquired spectrum by telecom service providers for establishment of terrestrial and/ or satellite-based telecom networks? If yes, whether it should be permitted? Kindly justify your response.

Q46. In case it is decided to allow low powered indoor consumer device-to-consumer device usages on license-exempt basis in V-band (57-64 GHz),

(a) Whether it should be permitted in entire band or part of the band? Kindly provide detailed response including the frequency carriers, which should be considered for license exemption with justification.

(b) Whether there is a need to define such indoor use? If yes, what should be the definition for such indoor use?

(c) What technical parameters should be prescribed including EIRP limits? Suggestions may kindly be made with supporting justification and international scenario.

Q47. Any other suggestions relevant to assignment of spectrum in E-band (71-76/81-86 GHz) and V-band (57-64 GHz) may kindly be made with detailed justification.

3.66 The following chapter examines the issues relating to valuation and pricing of E-band, V-band, MWA and MWB.

CHAPTER IV: VALUATION AND PRICING OF E-BAND, V-BAND, MWA AND MWB

A. E-band and V-Band

4.1 The Authority in its 2014 Recommendations on "*Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers*"[35] recommended to open both E-band and V-band with 'light touch regulation' and allotment on 'link to link' basis considering that light licensing would facilitate speedy allocation of the carriers and low pricing would enable operators to roll out the technology faster with lower CAPEX and OPEX. The Authority recommended the following:

- E-band carrier be charged at Rs. 10,000/- per annum per carrier of 250 MHz each. More than one channel can be allocated and allowed for aggregation. There should be initial promotional discount of 50% for three years from the date of allocation of first carrier in this band.

- In case of charging of V-band carriers since there are limitations in this band, the same be charged for Rs. 1,000/- per annum per carrier of 50MHz each. More than one channel can be allocated and allowed for aggregation. There should be initial promotional discount of 50% for three years from the date of allocation of first carrier in this band.

4.2 In view of the increased backhaul capacity requirements of Telecom Service Providers (TSPs) with Access service authorization/license and having Access Spectrum in the IMT bands, especially on account of 5G, DoT has decided to allot carriers in E-band spectrum for the purpose of backhaul on interim basis. Recently, vide "*Guidelines for allotment of E-band (71-76/81-86 GHz) carriers to Telecom Service Providers (TSPs) with Access Service authorization/license and having Access Spectrum in IMT bands*"[36] dated 25.07.2022, DoT has prescribed that for each E-band carrier of 250 MHz paired bandwidth, spectrum

[35] https://trai.gov.in/sites/default/files/MW%20Reco%20Final29082014.pdf

[36] https://dot.gov.in/sites/default/files/Guidelines%20for%20allotment%20of%20E-band%20dated%2025%2007%202022%20signed.pdf

charges will be levied @ 0.15% of Adjusted Gross Revenue of the TSPs in the interim period, which will be adjusted/recalculated retrospectively (from date of provisional assignment) based upon the pricing decided finally.

B. Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers

4.3 The Authority in its recommendation dated 29th August 2014 on "Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers"[37] had recommended the following: -

There should not be any upfront charges for the assignment of MWA and MWB carriers.

The AGR based spectrum charging mechanism for MWA carriers should be continued. However, for MWB carriers, the charging should be done on a link-to-link basis as is being done for all other terrestrial MW links.

Spectrum charges for MWB link shall be Rs. 13,900 per KM per annum.

The following spectrum charges for MWA carriers (28 MHz paired) should be made applicable for access service providers.

No. of MWA carriers assigned to a TSP	***Applicable Percentage of AGR as spectrum charge for MWA carriers***			
	13/15 GHz	***18/21 GHz***	***26/28/32***	***38/42 GHz***
1	*0.17%*	*0.12%*	*0.10%*	*0.07%*
2	*0.34%*	*0.24%*	*0.20%*	*0.14%*
3	*0.51%*	*0.36%*	*0.30%*	*0.21%*
4	*0.68%*	*0.48%*	*0.40%*	*0.28%*
5	*0.85%*	*0.60%*	*0.50%*	*0.35%*

[37] https://trai.gov.in/sites/default/files/MW%20Reco%20Final29082014.pdf

Note: For larger carrier sizes, spectrum charges shall increase proportionately. i.e. if the TSP has two carriers of 2x56 MHz of carriers in 18/21 GHz band, it shall be charged at 0.48% of AGR.

4.4 The Authority in 2014 had arrived at the spectrum charge for MWB link using the cost of laying optical fiber cable as a proxy. The Authority was of the view that using OFC for backhaul connectivity is a better option than using spectrum due to the inherent advantages such as OFC provides better quality and reliable connectivity and scalable bandwidth, the TSP not required to incur any capital/O&M expenditure if it chooses to take the circuit on lease basis and the leasing option is quick to implement whereas MW links installation take some time in processes like assignment of MWB carriers, SACFA clearance etc. The Authority while using the ceiling tariff prescribed in telecom tariff order (57th amendment) for 30 km distance, applied relevant factor and deducted the terminal costs and O&M charges, a spectrum charge of Rs. 13,900 per KM per annum for the MWB link was calculated.

4.5 Presently, charging for MWA as well as MWB spectrum assignments is done on a percentage of AGR basis. While spectrum for MWB is assigned on point-to-point basis, the applicable rate as a percentage of AGR does not vary with the number of P2P links demanded/ assigned in a carrier to a TSP.

4.6 For other entities i.e., TSPs other than Access Service License/ Authorization and non-TSP isolated captive users, MWB/ MWA carriers are assigned on a point-to-point (P2P) link basis. Charging for such spectrum assignments is done on a formula basis.

4.7 The spectrum charges for MWA/MWB for TSPs are levied as per OM dated J-14025/200(11)-NT dated 03.11.2006 (**Annexure 4.1**) and J-14025/200(11)/06-NT dated 10.11.2008 (**Annexure 4.2**). The spectrum charging for captive networks are being levied as per OM no. P-11014/34/2009-PP(II), (IV) dated 22.03.2012 (**Annexure 4.3**).

4.8 Further the frequency assignments and re-assignments for MWA/MWB carriers to TSPs having access service license/ authorization, are being considered administratively on provisional basis as per guidelines dated 16.10.2015 and its addendum dated 25.07.2022. The applicants (TSPs) are required to submit an undertaking with the following conditions:

"(i) The allotment of spectrum is provisional and subject to Govt's final decision on allotment & pricing of MWA and MWB spectrum;

(ii) In the event of final decision to allot spectrum only through auction process, the provisional allotment of spectrum shall be withdrawn;

(iii) In case the provisional allotment of spectrum is withdrawn, payment made towards spectrum charges or part thereof shall not be refunded;

(iv) In case the provisional allotment of spectrum is withdrawn, respective wireless users would obtain Non Dealer Possession Licence (NDPL) for possessing the wireless equipment or return the equipment to a DPL holder or shall be disposed off the same as per procedure.

(v) The revised spectrum charges, as finally determined through market related mechanism or otherwise, as may be applicable, shall be paid by us from the date of issue of Letter for provisional allotment of spectrum."

C. DoT's present reference

4.9 DoT vide its reference dated 12.08.2022 has requested *TRAI to provide its recommendations under the terms of clause 11(1)(a) of TRAI Act, 1997 as amended by TRAI Amendment Act 2000 on the following: -*

(a) *applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/usages, spectrum cap, payment terms, eligibility conditions, methodology of auction and other associated conditions for auction of E band spectrum for establishment of terrestrial and/ or satellite-based telecom networks.*

(b) *applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/usages, spectrum cap, payment terms, eligibility conditions methodology of auction and other associated conditions for auction of V band spectrum for establishment of terrestrial and/ or satellite-based telecom networks.*

(c) *a fresh recommendation on allocation methodology, quantum and pricing of MWA and MWB RF carriers in 6/7/ 13/15/18/21 GHz bands, for establishment of terrestrial and/ or satellite-based telecom networks as well as for non-commercial/ captive/ isolated use.*

D. Valuation of Spectrum

4.10 In the past, the Authority for the purpose of valuation and fixation of reserve price has used various models such as production function model, producer surplus model, revenue surplus model, Multiple regression model etc. These models rely on an extensive dataset regarding certain market and financial parameters related to the particular band, previous spectrum holding of the particular band etc. However, the E band, V band, MWA, MWB may be contemplated for auction in India for the first time. There is no historical auction data available to conduct comparative analysis involving auction determined prices in India. Hence, all the valuation methodologies used in IMT recommendations cannot be used for valuation of E band, V band, MWA, MWB due to lack of data related to the spectrum bands being put to auction. The Authority intends to explore the following possible methodologies for the valuation of these bands:

- Technical/Spectral efficiency approach
- Current spectrum charges
- International benchmarking

4.10.1 **Technical/Spectral efficiency approach**

- An alternative approach for valuation of these bands could be based on comparative values that can be achieved by using relative spectral efficiency approach where characteristics like capacity of a particular band can be compared with the same characteristics of another spectrum band and a spectral efficiency factor can be derived as a ratio.
- The authority in the past has used spectral efficiency factor for valuation of spectrum. It can be explored if the same is available in respect of E, V, MWA, MWB bands also and can be utilized as a basis for valuation of these bands.
- Moreover, the auction determined prices of mmWave bands for IMT/5G, across all the 22 licensed service areas is available from the recently concluded August 2022 IMT/5G auctions. It can be explored whether these prices can be used as a basis for valuation of E and V bands.

4.10.2 **Current Spectrum Charges**

- As stated in para----, presently spectrum for E, V, MWA and MWB bands are being assigned administratively. Spectrum charges for E-Band, MWA, MWB are levied as a percentage of AGR.
- It can be explored if the current spectrum charges being paid by operators may be used as a basis for valuation of spectrum in E, V, MWA and MWB bands.

4.10.3 **International benchmarking**

4.10.3.1 Using some other alternative approaches such as international benchmarking can also be explored for these bands. The international spectrum charges/price can serve as a basis for valuation of E, V, MWA, MWB bands. For this, it might be useful to obtain insights regarding the assignment and spectrum pricing mechanism followed internationally. The

following sections deal with the assignment and spectrum charging mechanism being followed in some countries.

E- Band

4.10.3.2 The licensing regime adopted for the allocation of E-Band in most of the countries is based on light licensing regulation[38]. As per the European Telecommunications Standards Institute (ETSI)'s "E-Band and V-Band - Survey on status of worldwide regulation, 2020" database[39] spanning a total of 109 countries, the E- Band in open for fixed services in 86 countries. Since the licensing methods vary across countries, for comparison purpose ETSI has estimated the fees considering the specific channel case of 250MHz/Year. The cross-country fees analysis and further insights based on the international data have been presented as follows:

Particulars	Number of Countries
Countries Surveyed	109
E- Band open for fixed services	86
E- Band closed for fixed services	17
Under review	6

Table4.1 E-Band: International Analysis on administrative fees

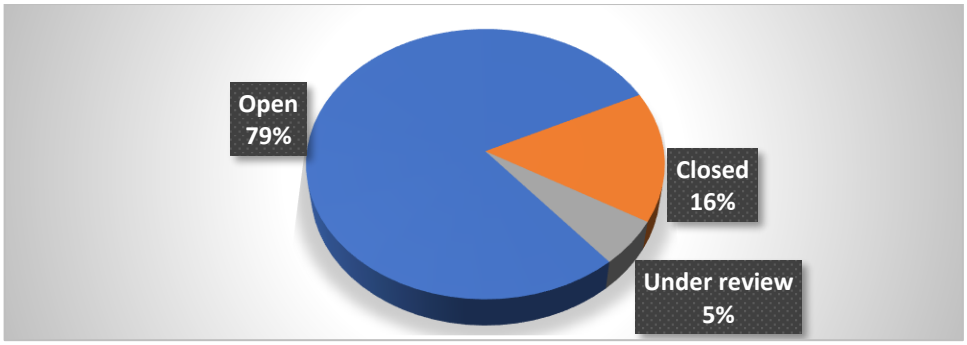

Figure 4.1 Status of E-Band

[38] https://www.etsi.org/images/files/ETSIWhitePapers/etsi-WP-37-E-Band-survey-on-Status-of-Worldwide-Regulation.pdf

[39] The database reporting the information country by country is available at http://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp9_e_band_and_v_band_survey_database.zip.

Country	Freq. Band [GHz]	Status of the band	FDD/TDD	Licence Regime	License Cost Estimation for 250MHz/Year [Euro]
Australia	71-76;81-86	Open	FDD/TDD	Light licensing	2240
Brazil		Open		Light licensing	950
Canada		Open	FDD/TDD	Licensed	240
Finland	71-76;81-86	Open	FDD		35
Greece	71-76;81-86	Open	FDD/TDD	Link by link	230
Indonesia	71-76;81-86	Open		Light licensing	2360
Iraq		Open		Link by link and Block	3600
Italy	71-76;81-86	Open	FDD	Link by link	2800
Malaysia	71-76;81-86	Open	FDD/TDD	Link by link	1000
New Zealand	71-76;81-86	Open	FDD/TDD	Link by link	115
Nigeria	71-74;81-84	Open			50
Russia	71-76;81-86	Open	FDD/TDD	Unlicensed	-
Saudi Arabia		Open		Link by link	8083
South Korea	71-76;81-86	Open	FDD/TDD	Light licensing	190
Turkey	71-76;81-86	Open		Link by link	1600
USA	71-76;81-86	Open	FDD/TDD	Light licensing	100

Table 4.2: E-band: Country-wise Administrative Fees, Source: ETSI's Database

V- Band

4.10.3.3 For the allocation of V-band the License-exempt regime is more prevalent. Ofcom opened the spectrum in the 59 - 64 GHz band for Fixed Wireless Systems (FWS) and to combine this with the existing 57 - 59 GHz band under one overall license exempt authorization approach for FWS[40]. The

[40] https://www.ofcom.org.uk/consultations-and-statements/category-1/59_64ghz

60GHz band is also unlicensed in Europe[41]. Moreover, frequencies in this band are also license-exempt in Australia, Canada, Japan, Republic of Korea and the United States.

4.10.3.4 However, DoT in its letter dated 11.10.2022 has mentioned that *[r]egarding V band spectrum, some countries had delicensed it during 2010 to 2014, when there was no visibility on the use of this spectrum for 5G/IMT and also the alternate telecommunications technologies like Wi-Fi have evolved to make it an equivalent technology to 4G/5G. Further, during last 7-8 years, technologies have developed which compete with 4G/5G/IMT. Therefore, hardly any country has delicensed V-band post TRAI's recommendations in 2014-2015 as 5G & equivalent technologies have been developed in these bands. Further, these band may also play key role in 6G technology.*

MWA and MWB Bands

4.10.3.5 Internationally the assignment of the spectrum for the microwave bands is based on link-to-link basis and is being done administratively. The annual spectrum fee/charge is calculated based on bandwidth factor, frequency factor, other technical factors etc. The countries have prescribed formulae for calculation of spectrum fee/charge, however, the same also varies from country to country.

E. Single vs. Multiple approaches

4.11 Further, the Authority, since September 2013, has taken a consistent view that instead of depending on the valuation arrived at using any single approach, it would be better to rely on a number of such approaches to arrive at a final reasonable valuation and then determine reserve price based on such valuation. Accordingly, the Authority has been using various approaches to arrive at the valuation of different spectrums bands and to determine the reserve price of

[41] https://www.researchgate.net/figure/Worldwide-allocations-of-60-GHz-unlicensed-bands-Even-though-III-V-technologies-such-as_fig1_221915925

different spectrum bands for the auction of various bands of spectrum from time to time. All of these valuation approaches have their merits as well as demerits and it would be appropriate to rely on a number of such approaches to arrive at a final reasonable valuation rather than depending on the valuation arrived at using any one approach. The Authority in its spectrum valuation exercises has used probabilistic average valuation (simple mean) of the valuations obtained through the different approaches attempted for valuation of a particular spectrum band. Taking into account the principle of equal probability of occurrence of each valuation, will it be appropriate to take the average valuation (simple mean) of the valuations obtained through the different approaches attempted for valuation of a particular spectrum band, as adopted by the Authority since September 2013 recommendations or some other methodology be used for valuation exercise.

F. Reserve price estimation

4.12 For arriving at the reserve prices, the Authority in its recommendation dated 11.04.2022 had primarily set reserve price equal to 70% of the mean of value the spectrum derived from all possible approaches.

4.13 A reserve price is the starting point for an ascending price auction and bidding is the means to true price discovery. It ensures a minimum guaranteed amount for the owner/ seller of goods and prevents excessive bargaining in the auction process. The reserve price set at too low level is inefficient in deterring collusion and if set at a too high level it can negatively impact participation in the auction. Thus, to ensure efficiency of the auction process, setting of reserve price at an optimal level is a prerequisite.

G. Payment Terms

4.14 DoT vide its reference has requested to provide recommendations on payment terms as well. It must be noted that the Notice Inviting Applications specify various aspects/parameters related to payment terms such as upfront payments, prepayment options, number of installments, moratorium period,

rate of discount etc. As can be seen from the above, DoT guidelines dated 25.07.2022 specify certain parameters related to payment terms such as number of installments within a financial year for payment of spectrum charges, interest on delayed payments etc. for administrative allotment of spectrum based on annual charges, however it may be noted that if spectrum is allocated through auction the payments terms will be distinct.

H. Issues for consultation:

4.15 In view of the discussions above in E-band, V-band, MWA and MWB, the following issues arise for consultation (**stakeholders are requested to respond to the questions / sub-questions separately**):

Q48. In case it is decided for assignment of spectrum on administrative basis, what should be the spectrum charging mechanism for assignment of spectrum for

i) E band
ii) V band
iii) MWA carriers and
iv) MWB carriers

separately for each of the following three categories: -

a) TSPs with Access Service License/ Authorization
b) TSPs with other than Access Service License/ Authorization
c) Other entities (non-TSP, for non-commercial/ captive/ isolated use)

Q49. Should the auction determined prices of spectrum bands for IMT/5G services be used as the basis for valuation of:

i) E band
ii) V band
iii) MWA carriers and
iv) MWB carriers

Please justify your responses.

Q50. Whether the value of spectrum in

i) E band
ii) V band
iii) MWA carriers and
iv) MWB carriers

be derived by relating it to the value of other bands by using spectral efficiency factor? If yes, with which spectrum band, should this band be related and what efficiency factor or formula should be used? Please justify your suggestions.

Q51. Should the current method of levying spectrum fees/charges for E band, MWA carriers and MWB carriers on AGR basis as followed by DoT, serve as a basis for the purpose of valuation of

i) E band
ii) V band
iii) MWA carriers and
iv) MWB carriers

If yes, please specify in detail what methodology is to be used in this regard?

Q52. Should the International administrative annual spectrum charges estimated based on specific channel case (250 MHZ/Year) of E-Band serve as a basis for the purpose of valuation of

i) E band
ii) V bands

Please provide detailed justification. If the answer to the question is yes, should the administrative annual spectrum charges be normalized for cross country differences? Please specify in detail the methodology to be used in this regard.

Q53. Should international benchmarking by comparing the auction determined price in countries where auctions have been concluded in E and V bands, if any, be used for arriving at the value of

i) E band

ii) V band

If yes, then what methodology can be followed in this regard? Please provide detailed information.

Q54. Whether any fixed administrative annual spectrum charges/ auction determined prices are available for other jurisdictions in case of MWA and MWB links? If yes, whether these charges/ prices can serve as a basis for the purpose of valuation of

i) MWA

ii) MWB carriers

Please provide with detailed justification.

Q55. Should the methodology, as adopted by the Authority in 2014 Recommendations for calculating spectrum charges for MWB links, be used as one of the valuation approach for MWB links? If yes, please provide detailed methodology for arriving at the valuation along with justification.

Q56. Whether the valuation for spectrum in E-band (71-76/ 81-86 GHz) and V-band (57-64 GHz), MWA (13 GHz/ 15 GHz/ 18 GHz/ 21 GHz), MWB (6 GHz/ 7 GHz) be done separately for each LSA, or pan-India basis, or any other geographic area/ link basis? Kindly justify your response.

Q57. Apart from the approaches highlighted above which other valuation approaches should be adopted for the valuation of

i) E band
ii) V band
iii) MWA carriers and
iv) MWB carriers

Please support your suggestions with detailed methodology, related assumptions and other relevant factors, etc.

Q58. Whether the value arrived at by using any single valuation approach for a particular spectrum band should be taken as the appropriate value of that band? If yes, please suggest which single approach/ method should be used. Please support your answer with detailed justification.

Q59. In case your response to the above question is negative, will it be appropriate to take the average valuation (simple mean) of the valuations obtained through the different approaches attempted for valuation of a particular spectrum band, or some other approach like taking weighted mean, median etc. should be followed? Please support your answer with detailed justification.

Q60. Should the reserve price be taken as 70% of the valuation of spectrum? If not, then what ratio should be adopted between the reserve price for the auction and the valuation of the spectrum in different spectrum bands and why? Please support your answer with detailed justification.

Q61. In case of auction-based assignment of

i) **E band**
ii) **V band**
iii) **MWA carriers and**
iv) **MWB carriers**

what should the payment terms and associated conditions relating to:

i. Upfront payment

ii. Moratorium period

iii. Total number of installments to recover deferred payments

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

Please support your answer with detailed justification.

CHAPTER V: ISSUES FOR CONSULTATION

Stakeholders are requested to provide responses to the following questions with detailed justifications:

Q1. What quantum of spectrum in different MWA and MWB frequency bands is required to meet the demand of TSPs with Access Service License/ Authorization? Whether MWA/ MWB spectrum is also required by TSPs having authorizations other than Access Service License/ authorization, and other entities (non-TSP, for non-commercial/ captive/ isolated use)? Information on present demand and likely demand after five years may kindly be provided as per the proforma given below with detailed justification:

(i) Present demand

Band	Quantum of spectrum required (per entity per LSA)		
	TSPs with Access Service License/ Authorization	**TSPs with other than Access Service License/ Authorization**	**Other entities (non-TSP, for non-commercial/ captive/ isolated use)**
6 GHz (5.925-6.425 GHz)			
7 GHz (7.125-7.425 GHz)			
7 GHz (7.425-7.725 GHz)			
13 GHz (12.750-13.250 GHz)			
15 GHz (14.5-15.5 GHz)			
18 GHz (17.7-19.7 GHz)			
21 GHz (21.2-23.6 GHz)			

(ii) Likely demand after five years

Band	Quantum of spectrum required (per entity per LSA)		
	TSPs with Access Service License/ Authorization	**TSPs with other than Access Service License/ Authorization**	**Other entities (non-TSP, for non-commercial/ captive/ isolated use)**
6 GHz (5.925-6.425 GHz)			
7 GHz (7.125-7.425 GHz)			
7 GHz (7.425-7.725 GHz)			
13 GHz (12.750-13.250 GHz)			
15 GHz (14.5-15.5 GHz)			
18 GHz (17.7-19.7 GHz)			
21 GHz (21.2-23.6 GHz)			

Q2. Whether spectrum for MWA and MWB should be assigned for the entire LSA on an exclusive basis, or on Point-to-Point (P2P) link basis? Response may be provided separately for (i) TSPs with Access Service License/ Authorization, (ii)TSPs having authorizations other than Access Service License/ authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) in the table given below with detailed justification:

Microwave bands	Spectrum should be assigned for the entire LSA on an exclusive basis, or on P2P link basis for -		
	TSPs with Access Service License/ Authorization	TSPs with other than Access Service License/ Authorization	other entities (non-TSP, for non-commercial/ captive/ isolated use)
MWB (6/7 GHz)			
MWA (13/15/18/21 GHz)			

Q3. Keeping in view the provisions of ITU's Radio Regulations on coexistence of terrestrial services and space-based communication services for sharing of the same frequency range, do you foresee any challenges in ensuring interference-free operation of terrestrial networks (i.e., MWA/ MWB point to point links in 6 GHz, 7 GHz, 13 GHz, and 18 GHz bands) and space-based communication networks using the same frequency range in the same geographical area? If so, what could be the measures to mitigate such challenges? Suggestions may kindly be made with justification.

Q4. What should be the carrier size for MWA and MWB carriers in each band viz. 6/7/13/15/18/21 GHz bands? Whether there is a need to prescribe a different carrier size based on different LSA categories or different user categories viz. (i) TSPs with Access Service License/ Authorization, (ii) TSPs with other than Access Service License/ Authorization and (iii) other users (non-TSP, for non-commercial/ captive/ isolated use)? If yes, suggestions may be made in the table given below with detailed justification.

Microwave bands	Carrier size (in MHz) for -		
	TSPs with Access Service License/ Authorization	**TSPs with other than Access Service License/ Authorization**	**other users (non-TSP, for non-commercial/ captive/ isolated use)**
MWB (6/7 GHz)			
MWA (13/15/18/21 GHz)			

Q5. Whether there is a need to assign MWA and MWB carriers in such a way that if a TSP acquires more than one carrier in a band, all assigned carriers are contiguous, and assigned frequency range(s) can be catered through a single equipment? If yes, kindly provide details of the frequency range(s) supported by the available equipment in each band. Any other suggestion(s) may kindly be made with detailed justification?

Q6. For the existing service licensees holding MWA/ MWB carriers, whether there is a need to create some specific provisions (as discussed in para 2.38 of this CP) such that if the licensee is successful in acquiring the required number of carriers through auction/ assignment cycle, its services are not disrupted? If yes, kindly provide a detailed response with justification.

Q7. Whether there is a need to review the existing ceiling on number of MWA carriers that can be held by a licensee? In case it is decided to review the ceiling on the number of MWA carriers that a licensee can hold,

(a) Whether a separate ceiling for each band (13 GHz/ 15 GHz/ 18 GHz/ 21 GHz) should be prescribed or an overall ceiling for MWA carriers taking all bands together?

(b) Whether different ceilings based on the service area category i.e., Metro/ Category 'A' Circles/ Category 'B' Circles/ Category 'C' Circles, needs to be prescribed?

(c) What should be the ceiling in terms of the number of carriers of 28 MHz per licensee in each case i.e., band-wise ceiling and overall ceiling for each service area category for -

(i) TSPs with Access Service License/ Authorization , and

(ii) TSPs with other than Access Service License/ Authorization?

(d) Any other relevant suggestion may be made with justification.

Kindly justify your response.

Q8. In case it is decided to assign MWB carriers exclusively on LSA basis to the TSPs, whether there is a need to prescribe any ceiling on the maximum number of MWB carriers that can be held by a TSP? Kindly justify your response.

Q9. In case it is decided to prescribe a ceiling on the number of MWB carriers that a TSP can hold,

(a) Whether separate ceiling for each band (6 GHz, 7 GHz (7.125-7.425 GHz) and 7 GHz (7.425-7.725 GHz)) should be prescribed or an overall ceiling for MWB carriers should be prescribed?

(b) Whether different ceiling based on the service area category i.e., Metro/ Category 'A' Circles/ Category 'B' Circles/ Category 'C' Circles, needs to be provided?

(c) What should be the ceiling in terms of number of carriers of 28 MHz per licensee in each case i.e., band-wise ceiling and overall ceiling for each service area category for

(i) TSPs with Access Service License/ Authorization , and

(ii) TSPs with other than Access Service License/ Authorization?

(d) Any other relevant suggestion may be made with justification.

Q10. Which methodology should be used for assignment of MWA carriers? Response may be provided in the table given below:

User category	**Assignment methodology** [Auction/ Administrative/ Any other (please specify)]	**Justification**
(i) TSPs with Access Service License/ Authorization		
(ii) TSPs with other than Access Service License/ authorization		
(iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use)		

Q11. In case you are of the opinion that certain user categories should be assigned MWA carrier P2P links by any methodology other than auction, should some MWA carriers be earmarked for such users? If

yes, how many carriers should be earmarked for each of such user category? Kindly justify your response.

Q12. Which methodology should be used for assignment of MWB carriers? The response may be provided in the table given below:

User category	**Assignment methodology** [Auction/ Administrative/ Any other (please specify)]	**Justification**
(i) TSPs with Access Service License/ Authorization		
(ii) TSPs with other than Access Service License/ Authorization		
(iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use)		

Q13. In case you are of the opinion that certain user categories should be assigned MWB carrier by any methodology other than auction, should some MWB carriers be earmarked for such users? If yes, how many carriers should be earmarked for such users? Kindly justify your response.

Q14. In case it is decided to assign MWA/MWB carriers to the TSPs with Access Service License/ Authorization through auction and to continue the existing P2P assignment of MWA/MWB carriers for TSPs other than Access Service License/ Authorization, who may be requiring to establish only a few links, what threshold limit in terms of number of links, may be prescribed, beyond which, the TSPs with

other than Access Service License/ Authorization should also be required to acquire MWA/ MWB carriers through auction? Kindly justify your response.

Q15. In case it is decided to assign MWA/ MWB carriers to all types of licensed TSPs through auction, should such TSPs be permitted to lease their spectrum acquired through auction, on P2P link basis, to other TSPs and other entities (non-TSP, for non-commercial/ captive/ isolated use) who may be requiring establishing only a few links? If yes,

(a) suggest a mechanism and regulatory framework for such leasing arrangement.
(b) Do you foresee any regulatory issues and potential misuse of such a regime? If yes, what measures could be put in place to mitigate the concerns?

Kindly justify your response.

Q16. In case MWA/MWB carriers are decided to be assigned through auction,

(a) Should the auction be conducted based on Simultaneous Multiple Rounds Ascending Auction (SMRA) method as adopted for IMT spectrum auction? Any other auction method may be suggested with detailed justification.

(b) what quantum of spectrum in each band (6/7/13/15/18/21 GHz) should be put to auction? Kindly justify your response.

Q17. In case it is decided to assign MWA and MWB carriers through auction,

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

(b) Whether there is a need to create a provision for surrender of MWA / MWB carriers? If yes, what should be the lock-in period and other associated terms and conditions?

Response may be given for each user category viz. (i) TSPs with Access Service License/ Authorization, (ii) TSPs with other than Access Service License/ Authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) with detailed justification.

Q18. In case it is decided to continue with the existing methodology of assignment of MWA/ MWB carriers, whether any change in the validity period, or process for augmentation/ surrender of carriers is required to be made? If yes, suggestions may be made with detailed justification.

Q19. What should be the eligibility conditions and associated conditions for assignment of spectrum in 6/ 7/ 13/ 15/ 18/ 21 GHz bands? Response may kindly be given for each user category viz. (i) TSPs with Access Service License/ Authorization, (ii) TSPs with other than Access Service License/ Authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) with detailed justification.

Q20. Whether there is a need to prescribe any roll out obligations for MWA/ MWB carrier assignment? Should the roll out obligations be linked to the number of carriers assigned to a TSP? Kindly justify your response.

Q21. In case it is decided to prescribe roll out conditions, what should be the roll-out obligations associated with the assignment of spectrum in 6/ 7/ 13/ 15/ 18/ 21 GHz bands? What provisions should be prescribed for non-fulfilment of the prescribed roll-out obligations? Response may kindly be given for each user category viz. (i) TSPs with Access Service License/ Authorization, (ii) TSPs with other than Access Service License/ Authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) with detailed justification.

Q22. Any other suggestions relevant to assignment of spectrum for MWA and MWB in 6/ 7/ 13/ 15/ 18/ 21 GHz frequency bands, may kindly be made with detailed justification.

Q23. What quantum of spectrum in E-band (71-76 / 81-86 GHz) and V-band (57-64 GHz) is required to meet the demand of TSPs with Access Service License/ Authorization? Whether spectrum in E-band and V-band is also required by the TSPs other than Access Service License/ Authorizations, and other entities (non-TSP, for non-commercial/ captive/ isolated use)? Information on present demand and likely demand after five years may kindly be provided as per the proforma given below:

(i) Present demand

Band	Quantum of spectrum required (per entity per LSA)		
	TSPs with Access Service License/ Authorization	**TSPs with other than Access Service License/ Authorization**	**Other entities (non-TSP, for non-commercial/ captive/ isolated use)**
E-band (71-76/81-86 GHz)			
V-band (57-64 GHz)			

(ii) Likely demand after five years

Band	Quantum of spectrum required (per entity per LSA) -		
	TSPs with Access Service License/ Authorization	**TSPs with other than Access Service License/ Authorization**	**Other entities (non-TSP, for non-commercial/ captive/ isolated use)**
E-band (71-76/81-86 GHz)			
V-band (57-64 GHz)			

Q24. Whether spectrum in E-band and V-band should be assigned exclusively on an LSA-basis, or on P2P link basis? Response may be provided separately for (i) TSPs with Access Service License/ Authorization, (ii) TSPs other than Access Service License/ Authorization, and (iii) other users (non-TSP, for non-commercial/ captive/ isolated use) in the table given below with detailed justification.

Microwave bands	Spectrum should be assigned for the entire LSA on exclusive basis, or on P2P link basis for -		
	TSPs with Access Service License/ Authorization	TSPs with other than Access Service License/ Authorization	other entities (non-TSP, for non-commercial/ captive/ isolated use)
E-band (71-76/81-86 GHz)			
V-band (57-64 GHz)			

Q25. Do you agree that the issues relating to the assignment of E-band and V-band for space-based communication services and its coexistence with terrestrial networks may be taken up at a later date? If not, the concerns and measures to overcome such concerns may kindly be suggested with relevant details.

Q26. Whether it will be appropriate to continue with the Frequency Division Duplexing (FDD) based configuration as adopted for the provisional assignment of E-band carriers or Time Division Duplexing (TDD) based configuration should be adopted? Kindly justify your response.

Q27. Whether Frequency Division Duplexing (FDD) or Time Division Duplexing (TDD) based configuration should be adopted for V-band carriers? In case you are of the opinion that FDD based configuration should be adopted, detailed submissions may be made with band plan, ecosystem availability, and international scenario.

Q28. What should be the carrier size for assignment of spectrum in E-band (71-76/81-86 GHz) and V-band (57-64 GHz)? Whether there is a need to prescribe a different carrier size based on different LSA categories or different user categories viz. (i) TSPs with Access Service License/ Authorization, (ii) TSPs other than Access Service License/ Authorization and (iii) other users (non-TSP, for non-commercial/ captive/ isolated use)? If yes, suggestions may be made with detailed justification.

Q29. Whether there is a need to assign spectrum in E-band and V-band in such a way that if a TSP acquires more than one carrier, all the assigned carriers to a TSP are contiguous? Kindly justify your response.

Q30. Since E-band carriers will be reassigned as per the assignment methodology that will be finalized, to avoid any disruption of services to the consumers of the existing TSPs holding E-band carriers, whether there is a need to create a provision such that the TSP is given a choice to retain the same frequency carrier as long as such TSP is able to acquire the carriers in the new regime? Kindly justify your response.

Q31. Whether there is a need to prescribe the maximum number of carriers that can be held by a TSP in E-band and V-band? Kindly justify your response.

Q32. In case it is decided to prescribe a ceiling on the number of carriers that a licensee can hold in E-band and V-band,

(a) Whether different ceilings based on the service area category i.e., Metro/ Category 'A' Circles/ Category 'B' Circles/ Category 'C' Circles, need to be prescribed?

(b) Considering a carrier of 250 MHz (paired) spectrum for E-band, and 50 MHz (unpaired) spectrum for V-band, what should be the ceiling in terms of the number of carriers per licensee for each service area category for

(i) TSPs with access service License/ authorization holding IMT spectrum,

(ii) TSPs with access service License/ authorization not holding IMT spectrum, and

(iii) TSPs with other than Access Service License/ Authorization?

(c) Any other relevant suggestion may be made with justification.

Q33. Which methodology should be used for assignment of spectrum in E-band and V-band? Response may be provided in the table given below:

User category	**Assignment methodology** [Auction/ Administrative/ Any other (please specify)]	**Justification**
(iv) TSPs with Access Service License/ authorization		
(v) TSPs with other than Access Service License/authorization		
(vi) Other entities (non-TSP, for non-commercial/ captive/ isolated use)		

Q34. In case you are of the opinion that certain user categories should be assigned spectrum in E-band and V-band for P2P links by any

methodology other than auction, should some carriers be earmarked for such users? If yes, how many carriers should be earmarked for such users? Kindly justify your response.

Q35. In case it is decided to assign spectrum in E & V bands to the TSPs with Access Service License/ Authorization through auction and adopt P2P links assignment for TSPs other than Access Service License/ Authorization, who may be requiring to establish only a few links, what threshold limit in terms of number of links, may be prescribed, beyond which, the TSPs with other than Access Service License/ Authorization should be required to acquire spectrum in E-band and V-band bands through auction? Kindly justify your response.

Q36. In case it is decided to assign spectrum in E & V bands to all the TSPs through auction, should such TSPs be permitted to lease their spectrum acquired through auction, on P2P link basis, to the TSPs and other entities for non-commercial/ captive/ isolated use, who may be requiring to establish only a few links? What could be the regulatory issues and potential misuse of such a regime? What measures could be put in place to mitigate the concerns? Kindly justify your response.

Q37. In case it is decided to assign spectrum in E-band (71-76/ 81-86 GHz) and V-band (57-64 GHz) on an exclusive basis, should the spectrum be assigned on an LSA basis, or pan-India basis or for any other geographic area should be defined? Kindly justify your response.

Q38. What should be the scope of services/ usages for spectrum in E-band (71-76/ 81-86 GHz) and V-band (57-64 GHz) assigned through auction or any other assignment methodology? Kindly justify your response.

Q39. In case spectrum in E-band and V-band is decided to be assigned through auction,

(a) Should the auction be conducted based on Simultaneous Multiple Rounds Ascending Auction (SMRA) method as adopted for IMT spectrum auction? Any other auction method may be suggested with detailed justification.

(b) What quantum of spectrum in each band should be put to auction? Kindly justify your response.

Q40. In case it is decided to assign spectrum in E & V bands through auction,

(a) What should be the validity period?

(b) Whether there is a need to create a provision for surrender of E & V band? If yes, what should be the lock-in period and other terms and conditions?

Response may be given for each user category viz. (i) TSPs with Access Service License/ authorization, (ii) TSPs with other than Access Service License/ authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) with detailed justification.

Q41. In case it is decided to assign spectrum in E-band and V-band through any methodology other than auction, what should be the validity period, process for augmentation/ surrender of carriers, and other terms and conditions? Suggestions may be made with detailed justification.

Q42. What should be the eligibility conditions and associated conditions for assignment of spectrum in E-band (71-76/81-86 GHz) and V-band (57-64 GHz)? Response may be given for each user category viz. (i)

TSPs with Access Service License/ authorization, (ii) TSPs with other than Access Service License/ authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) with detailed justification.

Q43. Whether there is a need to prescribe any roll out obligations for spectrum in E-band and V-band? Should the roll out obligations be linked to the number of carriers assigned to a TSP? Kindly justify your response.

Q44. In case it is decided to prescribe roll out conditions, what should be the roll-out obligations associated with the assignment of spectrum in E-band and V-band? What provisions should be prescribed for non-fulfilment of the prescribed roll-out obligations? Response may kindly be given for each user category viz. (i) TSPs with Access Service License/ Authorization, (ii) TSPs with other than Access Service License/ Authorization, and (iii) Other entities (non-TSP, for non-commercial/ captive/ isolated use) with detailed justification.

Q45. Whether it is feasible to allow low powered indoor consumer device-to-consumer device usages on license-exempt basis in V-band (57-64 GHz), in parallel to use of the auction acquired spectrum by telecom service providers for establishment of terrestrial and/ or satellite-based telecom networks? If yes, whether it should be permitted? Kindly justify your response.

Q46. In case it is decided to allow low powered indoor consumer device-to-consumer device usages on license-exempt basis in V-band (57-64 GHz),

(a) Whether it should be permitted in entire band or part of the band? Kindly provide detailed response including the frequency

carriers, which should be considered for license exemption with justification.

(b) Whether there is a need to define such indoor use? If yes, what should be the definition for such indoor use?

(c) What technical parameters should be prescribed including EIRP limits? Suggestions may kindly be made with supporting justification and international scenario.

Q47. Any other suggestions relevant to assignment of spectrum in E-band (71-76/81-86 GHz) and V-band (57-64 GHz) may kindly be made with detailed justification.

Q48. In case it is decided for assignment of spectrum on administrative basis, what should be the spectrum charging mechanism for assignment of spectrum for

i) E band
ii) V band
iii) MWA carriers and
iv) MWB carriers

separately for each of the following three categories: -

a) TSPs with Access Service Authorization
b) TSPs with other than Access Service Authorization
c) Other entities (non-TSP, for non-commercial/ captive/ isolated use)

Q49. Should the auction determined prices of spectrum bands for IMT/5G services be used as the basis for valuation of:

i) E band
ii) V band
iii) MWA carriers and
iv) MWB carriers

Please justify your responses.

Q50. Whether the value of spectrum in

i) E band
ii) V band
iii) MWA carriers and
iv) MWB carriers

be derived by relating it to the value of other bands by using spectral efficiency factor? If yes, with which spectrum band, should this band be related and what efficiency factor or formula should be used? Please justify your suggestions.

Q51. Should the current method of levying spectrum fees/charges for E band, MWA carriers and MWB carriers on AGR basis as followed by DoT, serve as a basis for the purpose of valuation of

i) E band
ii) V band
iii) MWA carriers and
iv) MWB carriers

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

Q52. Should the International administrative annual spectrum charges estimated based on specific channel case (250 MHZ/Year) of E-Band serve as a basis for the purpose of valuation of

i) E band
ii) V bands

Please provide detailed justification. If the answer to the question is yes, should the administrative annual spectrum charges be normalized for cross country differences? Please specify in detail the methodology to be used in this regard?

Q53. Should international benchmarking by comparing the auction determined price in countries where auctions have been concluded in E and V bands, if any, be used for arriving at the value of

i) E band

ii) V band

If yes, then what methodology can be followed in this regard? Please provide detailed information.

Q54. Whether any fixed administrative annual spectrum charges/ auction determined prices are available for other jurisdictions in case of MWA and MWB links? If yes, whether these charges/ prices can serve as a basis for the purpose of valuation of

i) MWA

ii) MWB carriers

Please provide with detailed justification.

Q55. Should the methodology, as adopted by the Authority in 2014 Recommendations for calculating spectrum charges for MWB links, be used as one of the valuation approach for MWB links? If yes, please provide detailed methodology for arriving at the valuation along with justification.

Q56. Whether the valuation for spectrum in E-band (71-76/ 81-86 GHz) and V-band (57-64 GHz), MWA (13 GHz/ 15 GHz/ 18 GHz/ 21 GHz), MWB (6 GHz/ 7 GHz) be done separately for each LSA, or pan-India basis, or any other geographic area/ link basis? Kindly justify your response.

Q57. Apart from the approaches highlighted above which other valuation approaches should be adopted for the valuation of

i) E band
ii) V band
iii) MWA carriers and
iv) MWB carriers

Please support your suggestions with detailed methodology, related assumptions and other relevant factors, etc.

Q58. Whether the value arrived at by using any single valuation approach for a particular spectrum band should be taken as the appropriate value of that band? If yes, please suggest which single approach/ method should be used. Please support your answer with detailed justification.

Q59. In case your response to the above question is negative, will it be appropriate to take the average valuation (simple mean) of the valuations obtained through the different approaches attempted for valuation of a particular spectrum band, or some other approach like taking weighted mean, median etc. should be followed? Please support your answer with detailed justification.

Q60. Should the reserve price be taken as 70% of the valuation of spectrum? If not, then what ratio should be adopted between the reserve price for the auction and the valuation of the spectrum in different spectrum bands and why? Please support your answer with detailed justification.

Q61. In case of auction-based assignment of

i) E band

ii) V band

iii) MWA carriers and

iv) MWB carriers

what should the payment terms and associated conditions relating to:

i. Upfront payment

ii. Moratorium period

iii. Total number of installments to recover deferred payments

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

Please support your answer with detailed justification.

Annexure-1.1: DoT letter dated 12.08.2022

Government of India
Ministry of Communications
Department of Telecommunications
Wireless Planning & Coordination (WPC) Wing
6th Floor, Sanchar Bhawan, 20, Ashoka Road, New Delhi

No: L-14035/10/2022-BWA **Date: 12-08-2022**

To,

The Secretary
Telecom Regulatory Authority of India
Mahanagar Doorsanchar Bhawan
Jawahar Lal Nehru Marg (Old Minto Road)
New Delhi-110002.

Subject: Seeking TRAI recommendations for assignment of E&V Bands; and Microwave Access (MWA) & Microwave Backbone (MWB) spectrum in existing frequency bands of 6/7/ 13/15/18/21 GHz.

Sir,

TRAI had provided its recommendations dated 29.08.2014 on "Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers". In these recommendations, TRAI had also provided recommendations on allocation and pricing methodology for E band (71-76/81-86 GHz) and V bands (57-64 GHz) spectrum. Subsequent to DoT's back reference dated 16.10.2015, TRAI's response/letters dated 17.11.2015, 06.05.2016 and 15.07.2016 were also received by DoT.

2. The matter of E and V band spectrum assignment was deliberated in DoT and it emerged that while the spectrum in E and V bands should be assigned through auction for provisioning of commercial telecom services; there may be certain non-TSP/ non-commercial usages like captive/individual point to point/multipoint usages, which also need spectrum in these bands and where auction may not feasible.

2.1 In V band, the device/chipset eco-system supporting various technologies for data transfer between consumer's devices such as smartphones, camera, laptops etc, has developed. The technologies used for such devices are designed for short-range, indoor, interference-tolerant applications. Therefore, while the V band spectrum can be assigned through auction for establishment of indoor/outdoor telecom networks, allowing low power, indoor usages of V band on license-exempt basis for consumer device-to- consumer device data transfer may go a long way in serving greater public interest and realizing significant socio-economic gains.

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3. With regard to assignments of MWA & MWB spectrum in frequency bands 6/7/ 13/15/18/21 GHz to TSPs, it has been decided to seek a fresh recommendation of TRAI on allocation methodology, quantum and pricing of MWA and MWB RF carriers, in view of technological changes which have taken place over the years as well as considering the existing assignments to TSPs.

4. In view of the above, TRAI is requested to provide its recommendations under the terms of clause 11(1) (a) of TRAI Act, 1997 as amended by TRAI Amendment Act 2000 on the following:

(a) applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/usages, spectrum cap, payment terms, eligibility conditions, methodology of auction and other associated conditions for auction of E band spectrum for establishment of terrestrial and/ or satellite based telecom networks.

(b) applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/usages, spectrum cap, payment terms, eligibility conditions methodology of auction and other associated conditions for auction of V band spectrum for establishment of terrestrial and/ or satellite based telecom networks.

(c) quantum of spectrum to be earmarked for non-commercial/ captive/ isolated use in E and V bands; and methodology of assignment, where auction is not feasible and pricing for the same.

(d) feasibility, including technical parameters, for allowing low power, indoor, consumer device-to-consumer device usages on license-exempt basis, in parallel to use of the auction-acquired spectrum by telecom service providers for establishment of terrestrial and/ or satellite based telecom networks, in part or full V band.

(e) a fresh recommendation on allocation methodology, quantum and pricing of MWA and MWB RF carriers in 6/7/ 13/15/18/21 GHz bands, for establishment of terrestrial and/ or satellite based telecom networks as well as for non-commercial/ captive/ isolated use.

(f) provide any other recommendations deemed fit for the purpose mentioned under (a) to (e) above in these frequency bands, including the regulatory/technical requirements as enunciated in the relevant provisions of the latest ITU-R Radio Regulations.

This issues with the approval of the competent authority.

(Gulab Chand)
Joint Wireless Adviser
Email: gulab.chand@nic.in
011-23372183

Annexure-2.1: Details of the frequency carriers in each MWA and MWB bands

Band	6 GHz		7 GHz		7 GHz		13 GHz		15 GHz		18 GHz		21 GHz	
No. of carriers	8		5		5		8		15		32		40	
Frequency range	5925-6425 MHz		7125-7425 MHz		7425-7725 MHz		12.750-13.250 GHz		14.5-15.5 GHz		17.7-19.7 GHz		21.2-23.6 GHz	
Tx-Rx separation	252.04 Mhz		161 Mhz		154 Mhz		266 Mhz		420 Mhz		1010 Mhz		1232 Mhz	
Adjacent Channel separation	29.65 MHz		28 MHz		28 MHz		28 MHz		28 MHz		27.5 MHz*		28 MHz	
Channels	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink
F1/F1'	5945.20	6197.24	7138.5	7299.5	7442	7596	12765	13031	14515	14935	17727.5	18737.5	21238	22470
F2/F2'	5974.85	6226.89	7166.5	7327.5	7470	7624	12793	13059	14543	14963	17755.0	18765.0	21266	22498
F3/F3'	6004.50	6256.54	7194.5	7355.5	7498	7652	12821	13087	14571	14991	17782.5	18792.5	21294	22526
F4/F4'	6034.15	6286.19	7222.5	7383.5	7526	7680	12849	13115	14599	15019	17810.0	18820.0	21322	22554
F5/F5'	6063.80	6315.84	7250.5	7411.5	7554	7708	12877	13143	14627	15047	17837.5	18847.5	21350	22582
F6/F6'	6093.45	6345.49					12905	13171	14655	15075	17865.0	18875.0	21378	22610
F7/F7'	6123.10	6375.14					12933	13199	14683	15103	17892.5	18902.5	21406	22638
F8/F8'	6152.75	6404.79					12961	13227	14711	15131	17920.0	18930.0	21434	22666
F9/F9'									14739	15159	17947.5	18957.5	21462	22694
F10/F10'									14767	15187	17975.0	18985.0	21490	22722
F11/F11'									14795	15215	18002.5	19012.5	21518	22750
F12/F12'									14823	15243	18030.0	19040.0	21546	22778
F13/F13'									14851	15271	18057.5	19067.5	21574	22806
F14/F14'									14879	15299	18085.0	19095.0	21602	22834
F15/F15'									14907	15327	18112.5	19122.5	21630	22862
F16/F16'											18140.0	19150.0	21658	22890
F17/F17'											18167.5	19177.5	21686	22918
F18/F18'											18195.0	19205.0	21714	22946
F19/F19'											18222.5	19232.5	21742	22974
F20/F20'											18250.0	19260.0	21770	23002
F21/F21'											18277.5	19287.5	21798	23030
F22/F22'											18305.0	19315.0	21826	23058
F23/F23'											18332.5	19342.5	21854	23086
F24/F24'											18360.0	19370.0	21882	23114
F25/F25'											18387.5	19397.5	21910	23142
F26/F26'											18415.0	19425.0	21938	23170
F27/F27'											18442.5	19452.5	21966	23198
F28/F28'											18470.0	19480.0	21994	23226
F29/F29'											18497.5	19507.5	22022	23254
F30/F30'											18525.0	19535.0	22050	23282
F31/F31'											18552.5	19562.5	22078	23310
F32/F32'											18580.0	19590.0	22106	23338
F33/F33'													22134	23366
F34/F34'													22162	23394
F35/F35'													22190	23422
F36/F36'													22218	23450
F37/F37'													22246	23478
F38/F38'													22274	23506
F39/F39'													22302	23534
F40/F40'													22330	23562

Annexure 2.2: DoT's guidelines dated 16.10.2015 for frequency assignments and re-assignments for MWA/MWB carriers to TSPs having access service authorization.

No. L-14035/19/2010-BWA (Pt)
Ministry of Communication & Information Technology
Department of Telecommunication
Wireless Planning and Coordination Wing

New Delhi dated, the 16th October, 2015

GUIDELINES

Considering the immediate requirement of Microwave Access (MWA) and Microwave Backbone (MWB) spectrum of telecom service providers, it has been decided to allot such spectrum for the interim period provisionally, pending the final decision in the matter by the Government.

2. The interim/ provisional allotment of MWA/ MWB carriers will be subject to following terms, conditions and criteria:

i) TSPs would be allotted, including the present holdings, a maximum of 4 carriers for Metro & Category A Service Area, 3 carriers for Category B and Category C Service Areas for MWA, subject to availability.

ii) Microwave Backbone carrier allotment will be considered on link to link basis subject to availability.

iii) Each Microwave carrier refers to 28 MHz paired bandwidth in 13, 15, 18 and 21 GHz bands for MWA and in sub 10 GHz band (s) for MWB.

iv) For the interim period, the charging of MWA and MWB carriers will be done as per rates mentioned in Order no. J-14025/200(11)/ 06-NT Dated 3rd November' 2006 and its amendments of even no. dated 10th November' 2008 and 19th February' 2009.

v) The applicants (TSPs) are required to submit an *undertaking* and also enter into an *Frequency Agreement* (proformas enclosed herewith), dully filled in, before their request for the allotment of MWA/ MWB carriers is considered.

vi) All MWA/ MWB carrier/spectrum allotted, as an interim measure, will be purely on temporary and provisional basis and all such allottees will have to participate in the allotment methodology as decided by the Government after considering the recommendations of TRAI on the subject.

vii) In the event of decision of the Government to allot MWA carrier/ spectrum by auction, the carriers allocated as an interim measure, will stand reverted back to the Government after a period of three months from date of finalisation of results of aforesaid auction, in case such allottees fail to participate and/or win back the carriers/spectrum provisionally allotted as an interim measure.

viii) In the event of decision of the Government to allot MWA carrier/ spectrum by a methodology other than the auction, the carriers allocated as an interim measure, will stand reverted back to the Government after a period of three months, in case such allottees fail to participate in the said process and/or not being able to get back the provisionally allotted carriers/spectrum, as per the methodology.

-½-

ix) The licensees whose licenses have expired in November' 2014 or licenses expiring in future, will be allowed to hold the carriers allotted to them as per Clause 8.4 of UL guidelines on a purely provisional basis till the ongoing process of TRAI consultation is completed and a final decision thereon is taken by the Government; thereafter, MWA/ MWB carriers may be regulated in accordance with above Para (vii) and (viii) of this Guideline/ OM.

x) Due notice will be given to such allottees who have been provisionally allotted the carriers/spectrum as an interim measure and have not been able to get back the spectrum in full or in part.

xi) During the said interim period, the present charging mechanism, as mentioned above, will continue subject to the condition that for the spectrum/carriers allotted during interim period, the TSPs will have to pay the charges with retrospective effect (i.e. from the date of issue of letter for allotment of carriers as interim measure) as finally determined through the auction process/ market related process or any other methodology decided by the Government.

Encls: As above
(Undertaking and Frequency Agreement Proforma)

16.10.2015
(Bhagirath)
Deputy Wireless Adviser

Copy to:
i) All concerned
ii) Sr. DWA (ASMS), WPC Wing, DoT for uploading on the WPC Wing website
iii) Director (IT), DoT, for uploading on the DoT website

-2/2-

Annexure 2.3: Addendum to DoT guidelines dated 16.10.2015 issued on 25.07.2022.

No. L-14035/19/2010-BWA (Pt-II)
Ministry of Communications
Department of Telecommunications
Wireless Planning and Coordination Wing

New Delhi dated 25th July, 2022

Subject: Addendum to the Guidelines dated 16.10.2015 regarding allotment of MWA/MWB carriers to TSPs with Access Service authorization/license.

In view of the increased requirements of backhaul on account of 5G, it has been decided to increase the limit of maximum number of Microwave Access carriers that can be assigned to a Telecom Service Provider with Access Service authorization/license on provisional basis vide Guidelines dated 16.10.2015, from existing 4 carriers (in Metro, Cat 'A' LSA) /3 carriers (in Cat 'B' & Cat 'C' LSA) to 8 carriers (in Metro, Cat 'A' LSA) / 6 carriers (in Cat 'B' & Cat 'C' LSA) w.e.f. the date of issue of this addendum.

2. A separate O.M shall be issued for modifying the Frequency Agreement, attached with the Guidelines dated 16.10.2015.

3. Other terms and conditions of the Guidelines dated 16.10.2015 will remain same.

AVNEESH KUMAR
Digitally signed by AVNEESH KUMAR
(Avneesh Kumar)
Assistant Wireless Adviser to the Govt. of India
Date: 2022.07.25 19:56:18 +05'30'

Copy To:

i. All Concerned
ii. Sr. DWA (ASMS), WPC Wing, DoT for uploading on the WPC Wing's website.
iii. Director (IT), DoT, for uploading on the DoT website.

Annexure 2.4: Interim Policy dated 13.07.2022 for frequency assignments.

Government of India
Ministry of Communications
Wireless Planning & Coordination Wing
Sanchar Bhawan, 20-Ashoka Road, New Delhi-110 001

No. R-11014/15/2012-NT (Pt.) Date: 13th July, 2022

OFFICE MEMORANDUM

It has been decided, as an interim measure, for a period of **Six months** from the date of issue of this OM, to continue to make frequency assignments for broadcasting (including community radio), H/V/UHF/SHF fixed/mobile networks (including CMRTS), radars, experimentation, demonstration and satellite based applications (including DTH, Teleport, DSNG, VSAT, NLD, ILD, INMARSAT).

2. The annual spectrum usage charges shall be continued to be levied as per Orders No. P-11014/34/2009-PP(I), (II), (III) & (IV) dated 22nd March, 2012 and VSAT Orders No. R-11014/9/2001-LR dated 16th April, 2003 & J-19045/03/2018-SAT dated 13th September, 2021 and Inmarsat based Gloabal Satellite Phone Services order No. J-19044/03/2015-SAT dated 28th June, 2021, unless otherwise amended.

3. The allotment of the spectrum would be made with the following conditions and upon obtaining an undertaking from applicants that they would agree for assignment of frequencies with the following conditions:

(i) The allotment of spectrum is provisional and subject to Govt's decision on allotment & pricing of spectrum;

(ii) In the event of final decision to allot spectrum only through auction process, the provisional allotment of spectrum shall be withdrawn;

(iii) In case the provisional allotment of spectrum is withdrawn, payment made towards spectrum charges or part thereof shall not be refunded;

(iv) In case the provisional allotment of spectrum is withdrawn, respective wireless users would obtain Non Dealer Possession Licence (NDPL) for possessing the wireless equipment or return the equipment to a DPL holder or shall be disposed-off the same as per procedure.

(v) The respective wireless users would be required to give an undertaking to pay the revised spectrum charges, as finally determined through market related mechanism or otherwise as may be applicable, from the date of Letter of Intent (LoI) for provisional allotment of spectrum.

3.1. Upon shift/ change in policy from administrative allotment, due notice of 3 months of such change, time to make appropriate arrangements, etc. will be given and the same has to be complied with by the wireless users.

4. The above conditions in Para 3 and 3.1 will be added in the Letter of Intent (LoI), Decision to grant License (D/L) and the Wireless Operating Licence (WOL) also.

KHAGENDRA SINGH

Digitally signed by KHAGENDRA SINGH
Date: 2022.07.13 11:28:18 +05'30'

(Khagendra Singh)
Deputy Wireless Adviser
to the Government of India
Ph- 011 2303 6633

To,
All concerned

Copy for information to:

I. DDG (WPF), Wireless Finance Division.
II. Director, Wireless Monitoring Organisation.
III. JWA WPC (HQ)/ JWA, RLO (WR/ER/NR/SR)/ Sr. DWA, RLO(NE)
IV. All Sr. DWAs, WPC Wing, DoT HQ.
V. Director (IT), DoT, for uploading on DoT's website.
VI. Sr. DWA (ASMS), for uploading on WPC Wing's website.

Annexure 3.1: Guidelines dated 25.07.2022 for allotment of E-band carriers

No. L-14035/19/2010-BWA (Pt-II)
Ministry of Communications
Department of Telecommunications
Wireless Planning and Coordination Wing

New Delhi dated 25th July, 2022

Subject: Guidelines for allotment of E-band (71-76/81-86 GHz) carriers to Telecom Service Providers (TSPs) with Access Service authorization/license and having Access Spectrum in IMT bands.

In view of the increased backhaul capacity requirements of TSPs with Access Service authorization/license and having Access Spectrum in the IMT bands, especially on account of 5G, it has been decided to allot carriers in E-band spectrum for the purpose of backhaul on interim basis as per the following guidelines:

1. TSPs, based upon their application, would be allotted a maximum of 2 (two) carriers of 250 MHz each (paired) bandwidth in E-band (71-76/81-86) GHz for their backhaul purpose in the LSAs where they are holding Access Spectrum in IMT bands.

2. For each E band carrier of 250 MHz paired bandwidth, Spectrum Charges will be charged @ 0.15% of AGR (Adjusted Gross Revenue) of the TSPs in the interim period, which will be adjusted/recalculated retrospectively (from date of provisional assignment) based upon the pricing decided finally. No interest shall be paid/ charged on the excess / shortfall amount, if any, while making such adjustment/recalculation. Final assignment of carriers will be decided accordingly.

3. Spectrum Charges shall be payable in four quarterly instalments during each financial year (FY). Quarterly instalments of Spectrum Charges for the first three quarters of a financial year shall be paid within 15 days of the completion of the relevant quarter. However, for the last quarter of the financial year, the Licensee shall pay the Spectrum Charges by 25th March on the basis of expected revenue for the quarter, subject to minimum payment equal to the revenue share paid for the previous quarter.

4. Any delay in payment of spectrum charges, payable, or any other dues payable under the License beyond the stipulated period will attract interest at a rate which will be 2% above the one-year Marginal Cost of Lending Rate (MCLR) of the State Bank of India existing as on the beginning of the Financial Year (namely 1st April) in respect of the spectrum charges pertaining to the said Financial Year. The interest shall be compounded

annually. A part of the month shall be reckoned as a full month for the purpose of calculation of interest. A month shall be reckoned as an English calendar month.

5. All E-band carriers assigned, as an interim measure, will be purely on temporary and provisional basis and all such assignees will have to participate in the auction and/or any other assignment methodology, as decided by the Government after considering the recommendations of the TRAI in this regard.

6. The E- band carriers, assigned as an interim measure, will stand reverted back to the Government, after a period of three months from the date of finalization of results of aforesaid activity as detailed/stipulated in para 5 above in case such assignees fail to get back the carriers/ spectrum provisionally assigned as an interim measure.

7. WPC Wing reserves the right to change or modify frequencies assigned to licensee without any notice in the interest of public or for proper conduct of telegraphs and or for security considerations.

8. Equipments conforming to TEC/ITU and other international standards and National Frequency Allocation Plan (NFAP) shall be deployed.

9. Any misuse i.e. use of E-band carriers allotted under these guidelines for purpose(s) other than backhaul will lead to immediate withdrawal of these carriers and invocation of relevant terms and conditions of the UL/UASL-Access Service Authorization.

10. The applicants (TSPs) are required to submit an undertaking as per enclosed proforma, with their request for the assignment of E- band carriers.

11. These guidelines shall be effective from the date of its issue.

Encl: Proforma of Undertaking

AVNEESH KUMAR

Digitally signed by AVNEESH KUMAR
Date: 2022.07.25 19:49:40 +05'30'

(Avneesh Kumar)
Assistant Wireless Adviser to the Govt. of India

Copy To:

i. All Concerned

ii. Sr. DWA (ASMS), WPC Wing, DoT for uploading on the WPC Wing's website.

iii. Director (IT), DoT, for uploading on the DoT website.

Undertaking for Interim/Provisional allotment of E-band (71-76/81-86 GHz) carriers

I/We.....on behalf of M/s..... hereby undertake to agree for the assignment of frequencies against our application vide letter No.....dated.....with the following conditions:

(i) The allotment of spectrum is provisional and subject to Government's final decision on allotment & pricing of E-band spectrum;

(ii) In the event of final decision to allot spectrum through auction process or any other methodology as finally decided by the Govt., I/We shall follow the process accordingly; failing which the spectrum shall be withdrawn by the Govt.

(iii) In case the provisional allotment of spectrum is withdrawn, payment made towards spectrum charges or part thereof shall not be refunded;

(iv) In case the provisional allotment of spectrum is withdrawn, I/We would obtain Non-Dealer Possession License (NDPL) for possessing the wireless equipment or return the equipment to a DPL holder or shall dispose off the same as per procedure;

(v) The revised spectrum charges, as finally determined through market related mechanism or otherwise, as may be applicable, shall be paid by us from the date of issue of Letter for provisional allotment of spectrum.

(vi) The carriers allotted thus would only be used for backhaul purpose in the network.

(vii) I/We hereby agree and unequivocally undertake to fully comply with all the terms and conditions stipulated in the Guidelines dated.....for allotment of E-band (71-76/81-86 GHz) carriers without any deviations or reservations.

Place.....

Date.....

Signature of Authorized Signatory*

Name.....

Designation.....

*The document in support of being the authorized signatory (i.e. Board Resolution and POA) to be attached.

AVNEESH KUMAR

Digitally signed by AVNEESH KUMAR
Date: 2022.07.25 19:50:10 +05'30'

Annexure 4.1: DoT's Order dated 03.11.2006 on spectrum charges for MWA/ MWB

Government of India
Ministry of Communications & IT
Department of Telecommunications
WPC Wing

Sanchar Bhavan, 20 Ashoka Road,
New Delhi – 110 001

No. J-14025/200(11)/06-NT

Dated the 3rd November 2006

ORDER

Sub: Spectrum charges for Microwave (MW) Access and MW Backbone Networks of GSM and CDMA based telecom service providers

In pursuance of the powers conferred by Section 4 of the Indian Telegraph Act, 1885 (13 of 1885) and in supersession of the Order No. L-14047/01/2002-NTG dated 18th April 2002 and in partial modification of Order No. R-11014/4/87-LR(Pt) dated 20th July 1995 and Corrigendum No. R-11014/26/2002-LR dated 1st April 2003, the central government hereby prescribes the following royalty charges (based on revenue share) for Microwave (MW) Access (normally in the frequency band 10 GHz and beyond) and MW Backbone networks (generally below 10 GHz frequency band) of GSM and CDMA based telecom service providers:

2.1 The following revenue share percentage(s) shall be levied for assignment of Microwave networks of GSM and CDMA based telecom service providers

Spectrum Bandwidth	Spectrum charges as percentage of AGR	Cumulative spectrum charges as percentage of AGR
First carrier of 28 MHz (paired)	0.15 %	0.15%
Second carrier of 28 MHz (paired)	0.20%	0.35%
Third carrier of 28 MHz (paired)	0.20 %	0.55 %
Fourth carrier of 28 MHz (paired)	0.25 %	0.80 %
Fifth carrier of 28 MHz (paired)	0.30 %	1.10 %
Sixth carrier of 28 MHz (paired)	0.35 %	1.45 %

2.2 The above spectrum charges (as percentage of AGR) are applicable for both for MW access carriers (in Metros and other telecom service areas) as well as the MW backbone carriers separately.

2.3 While the first microwave access carrier can be allotted for the complete service area, subsequent carriers shall be allotted based on justification and for the cities/ districts where it is found to be essential.

2.4 However, the revenue share would be based on the AGR for complete service area for simplicity of calculations, which is one of the main features of the revenue share regime.

Contd... 2/-

2.5 Assignment of frequencies for MW access and MW backbone networks fc GSM and CDMA based telecom networks would continue to be considered on the basis of full justification of the requirements and availability of the spectrum, o case-to-case and link-to-link basis, after taking into consideration the spectrun requirement of the other users with a view to ensuring electromagnetic compatibility etc. The complete technical analysis and all related aspects of frequency assignments, including efficient use of spectrum, will apply before assigning frequencies for various MW access and MW backbone links. There will be nc obligation on the part of the Government to assign frequencies for such purposes.

2.6 These charges include the royalty charges for spectrum usages and licence fee for the fixed stations in the MW access and MW backbone links.

2.7 The assignment of MW access and MW backbone frequencies shall not be exclusive for any service provider and will be shared with other services / users.

2.8 In addition, the charges for GSM spectrum (in 900 / 1800 MHz band) and CDMA spectrum (in 800 MHz band) will continue to be levied in accordance with the existing orders on the subject.

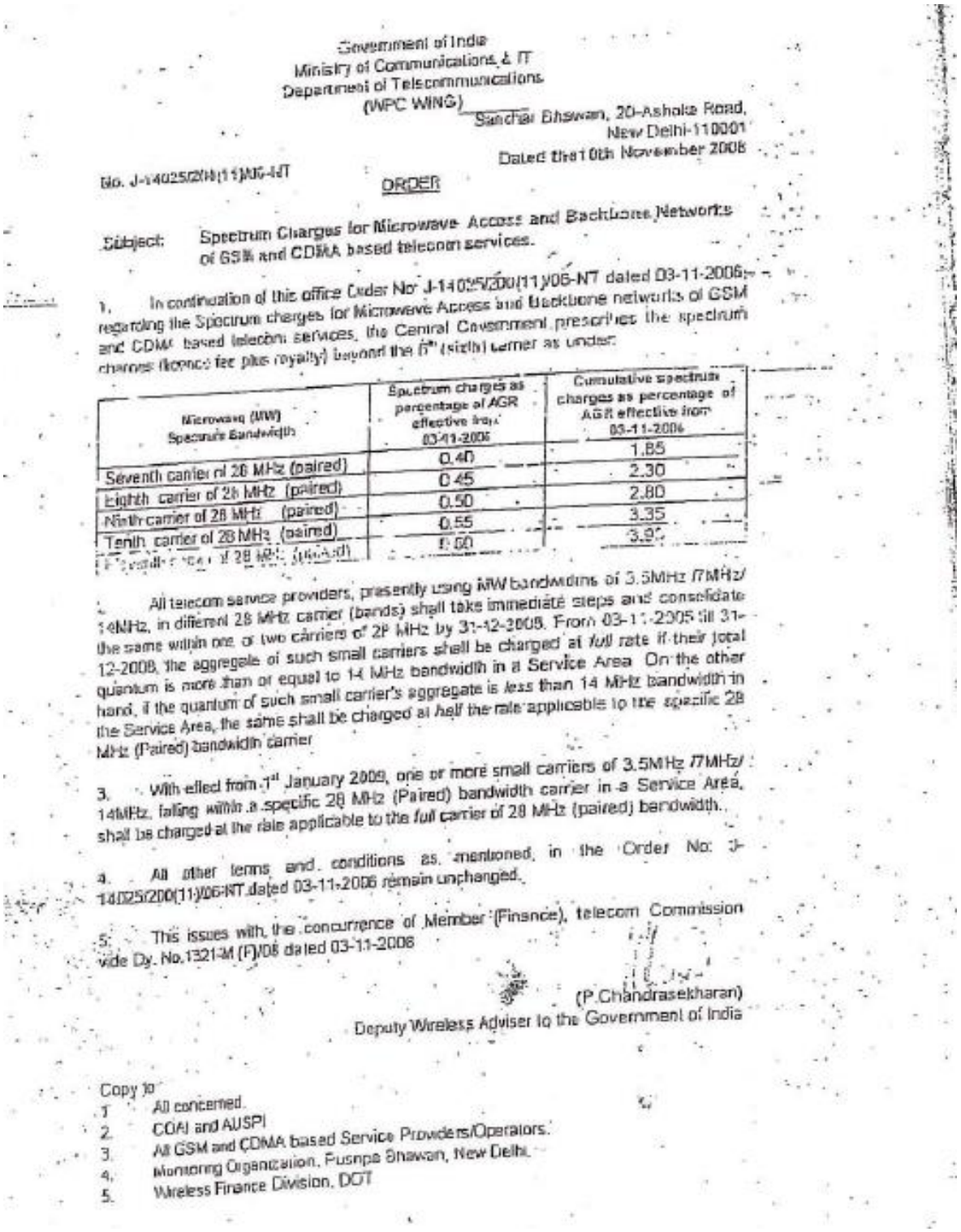
3. These orders shall come into force from the date of issue.

(Sukhpal Singh)
Assistant Wireless Adviser to the Government of India

Copy to:

1. All Concerned.
2. COAI.
3. AUSPI
4. All GSM based Operators.
5. All CDMA based operators.
6. Monitoring Organisation
7. Wireless Finance Division

Annexure 4.2: DoT's Order dated 10.11.2008 on spectrum charges for MWA/ MWB



Government of India
Ministry of Communications & IT
Department of Telecommunications
(WPC WING)
Sanchar Bhawan, 20-Ashoka Road,
New Delhi-110001

Dated the 10th November 2008

No. J-14025/2(11)/06-NT

ORDER

Subject: Spectrum Charges for Microwave Access and Backbone Networks of GSM and CDMA based telecom services.

1. In continuation of this office Order No. J-14025/200(11)/06-NT dated 03-11-2006 regarding the Spectrum charges for Microwave Access and Backbone networks of GSM and CDMA based telecom services, the Central Government prescribes the spectrum charges (licence fee plus royalty) beyond the 6th (sixth) carrier as under:

Microwave (MW) Spectrum Bandwidth	Spectrum charges as percentage of AGR effective from 03-11-2006	Cumulative spectrum charges as percentage of AGR effective from 03-11-2006
Seventh carrier of 28 MHz (paired)	0.40	1.85
Eighth carrier of 28 MHz (paired)	0.45	2.30
Ninth carrier of 28 MHz (paired)	0.50	2.80
Tenth carrier of 28 MHz (paired)	0.55	3.35
[illegible] of 28 MHz (paired)	0.60	3.95

2. All telecom service providers, presently using MW bandwidths of 3.5MHz /7MHz/ 14MHz, in different 28 MHz carrier (bands) shall take immediate steps and consolidate the same within one or two carriers of 28 MHz by 31-12-2008. From 03-11-2006 till 31-12-2008, the aggregate of such small carriers shall be charged at *full* rate if their total quantum is more than or equal to 14 MHz bandwidth in a Service Area. On the other hand, if the quantum of such small carrier's aggregate is *less* than 14 MHz bandwidth in the Service Area, the same shall be charged at *half* the rate applicable to the specific 28 MHz (Paired) bandwidth carrier.

3. With effect from 1st January 2009, one or more small carriers of 3.5MHz /7MHz/ 14MHz, falling within a specific 28 MHz (Paired) bandwidth carrier in a Service Area, shall be charged at the rate applicable to the *full* carrier of 28 MHz (paired) bandwidth.

4. All other terms and conditions as mentioned in the Order No. J-14025/200(11)/06-NT dated 03-11-2006 remain unchanged.

5. This issues with the concurrence of Member (Finance), telecom Commission vide Dy. No.1321-M (F)/08 dated 03-11-2006.

(P.Chandrasekharan)
Deputy Wireless Adviser to the Government of India

Copy to:
1. All concerned.
2. COAI and AUSPI
3. All GSM and CDMA based Service Providers/Operators.
4. Monitoring Organization, Pusnpa Bhawan, New Delhi.
5. Wireless Finance Division, DOT

Annexure 4.3: DoT's Order dated 22.03.2012 on royalty charges and license fees for captive networks

Government of India
Ministry of Communications & IT
Department of Telecommunication
Wireless Planning & Co-ordination (WPC) Wing

Sanchar Bhavan,
20, Ashoka Road,
New Delhi-110 001

No. P-11014/34/2009-PP (II) Date: 22nd March, 2012

ORDER

Subject: Royalty charges for Assignments of Frequencies to 'Captive Users' (users being charged on formula basis) including all Government Users, involving **Multi Channel** Operations for Fixed/ Land/ Land Mobile Stations.

In pursuance of Power conferred by section 4 of the Indian Telegraph Act, 1885(13 of 1885) and in supersession of this Ministry's Orders No. R-11014/26/2002-LR dated 06.05.2003, No. R-11014/26/2002-LR dated 01.04.2003, No. R-11014/4/87-LR (pt.) dated 20.07.1995 and No. R-11014/4/87-LR dated 09.12.1987, the Central Government has decided the following Royalty charges for Assignments of Frequencies to 'Captive Users' (users being charged on formula basis) including all Government Users, involving **Multi Channel** Operations for Fixed/ Land/ Land Mobile Stations:-

2. *Annual Royalty* is calculated as per the following formula and rules:

$$\textit{Annual Royalty (in Rupees)} = \sum_{i=1}^{n} M_i \times W, \text{ where n = no. of carriers.}$$

i. The Basic Royalty (M) given below is for *one* carrier frequency in a *Basic Link* (simplex) of 2 Fixed/ Land/ Land Mobile stations (1 station for broadcasting).

ii. Duplex circuits (with two central frequencies) and Semi-duplex circuits shall be charged at twice the rate of simplex (single central frequency) circuits.

iii. For multi-frequency circuits, even if operating in simplex mode, the Basic Royalty shall be charged for each frequency separately.

iv. For the purpose of charging Royalty under Table-B, the *Bandwidth Factor W* shall be as per *Table-C*, given below.

v. For all carrier frequencies, the chargeable bandwidth shall include the *Guard Bands* required to be provided as per *ITUs*.

vi. The rates of Royalty apply to the specified *polarization(s)* of the assigned frequencies.

vii. In addition to above, the explanatory "Notes" on the applicability of royalty charges, are as following:

- To determine the "Maximum Distance" slab applicable to a case, the 'maximum power rating/ assigned' of the transmission equipment be considered, and expressly recorded in the assignment instrument Decision Letter, Agreement-in-Principle, or Wireless Operating License (DL/ AIP/ WOL).

- The *duration* of a radio frequency assignment will normally be one or two years. If an applicant desires, and frequencies are available, the duration of assignment may be fixed as three or four or five years.
- Before issuing any DL/ AIP/ WOL, full amounts of Royalty shall be submitted by the applicant in advance for the entire duration of the DL/ AIP/ WOL.
- For all assignments of frequencies, all applicants or users shall pay the applicable Royalty, License Fee, etc. **at the rates and terms in force from time to time, all previously paid amounts being adjusted on pro-rata basis.**

Table-B For The 'M' Factor

Distance Cat.	"Maximum Distance (KM) Over Which the F/L/LM Network would operate"	Royalty Charges (in Rs.) for of the Basic Link.
		M
I	<= 2	*1500*
II	<= 5	*3000*
III	> 5 <= 25	*6000*
IV	> 25 <= 60	*12000*
V	> 60 <= 120	*22500*
VI	> 120 <= 500	*37500*
VII	> 500	*50000*

Table-C for The 'W' Factor

Slabs of Adjacent Channel Separation (BW), in MHz	Values of W
Up to and including 2	30
More than 2 but < = 3.5	40
More than 3.5 but < = 7	60
More than 7 but < = 14	90
More than 14 but < = 28	120
> 28	120+30 x (Excess bandwidth to 28 MHz / 7) @

@: That is, in steps of 7 MHz or part thereof.

viii. Any "single channel service" that uses a channel bandwidth in excess of 375 KHz shall be covered by Charging Table-C above, where the Bandwidth Factor "W" is used from the lowest value of 30 onwards.

3. For Charging of "Licence fee and other fees, Surcharge/ late fee and Charging Methodologies for Royalty / licence fees, Order No. No. P-11014/34/2009-PP (IV) dated 22nd March, 2012 shall be applicable

4. This issues with the concurrence of the Wireless Finance Division, vide this Dy. No.482/Sr.DDG(WPF), dated 19/3/12.

5. This Order shall come into force from 1st April 2012.

(Viresh Goel)
Deputy Wireless Advisor
to the Government of India

Copy to:

1. All concerned
2. Wireless Finance Division
3. Wireless Monitoring Organisation
4. Director, IT DoT for uploading on DoT website
5. DWA(ASMS) for uploading on WPC Wing website

Government of India
Ministry of Communications & IT
Department of Telecommunication
Wireless Planning & Co-ordination (WPC) Wing

Sanchar Bhavan,
20, Ashoka Road,
New Delhi-110 001

No. P-11014/34/2009-PP (IV)

Date: 22nd March, 2012

ORDER

Subject: Licence fee and other fees, Surcharge/ late fee and Charging Methodologies for Royalty / licence fees for 'Captive Users' (users being charged on formula basis) including all Government Users.

In pursuance of Power conferred by section 4 of the Indian Telegraph Act, 1885(13 of 1885) and in supersession of this Ministry's Orders No. R-11014/28/2004-LR dated 23.03.2005, and No. R-11014/4/87-LR dated 20.07.1995 the Central Government has decided the following rates of Licensee fees, and other fees, Surcharge/ late fee and Charging Methodologies for Royalty / licence fees for different types of Assignments of Frequencies to 'Captive Users' (users being charged on formula basis) including all Government Users. :-

2. **License Fees**

Sl. No.	Type of License	Annual License Fee, Rs.	Remarks
i.	Fixed/ Land Station	500	Per station
ii.	Land Mobile Station	250	Per station
iii.	Captive paging (Hub)	2000	Per Hub
iv.	Maritime Mobile Station (fishing trawlers)	500	Per trawler
v.	Maritime Mobile Station (Ships)	5000	Per ship
vi.	Aero-mobile Station	5000	Per aircraft
vii.	USR (short range)	250	Per station
viii.	Fixed station of Microwave links/ Radar Station/NLD station/BTS	1000	Per station
ix.	CMRTS fixed station	500	Per fixed station
x.	CMRTS Mobile Station	250	Per mobile station; vehicle mounted or hand-held
xi.	Fixed station in Satellite Network, e.g., DTH/ Teleport/ DSNG/ NLD/ ILD/ DCP/ IP-II	1000	Per Fixed Station
xii.	Captive V-SAT	500	Per Hub or Terminal
xiii.	INMARSAT	250	For Mobile terminal
xiv.	INMARSAT	500	For Fixed terminal

NOTE: License Fee for standby sets shall also be charged at the same rates.

3. **Fees for issuing duplicate copies and License Modification**

Sl. No.	Type	Fee in Rupees
i.	Duplicate copy of License (Without Schedule)	500
ii.	Duplicate copy of Schedule(s) of a License	500
iii.	Duplicate copy of Renewal Certificate	250
iv.	License Modification	1000

4. **Charging Methodologies** for Royalty / licence fees:

i. No radio frequency be assigned, reserved, or blocked through a Decision Letter, Agreement-in-Principle, or any other instrument of like nature *unless* the applicant pays, in advance, all applicable license fees and royalty charges for the full duration of authorization/ assignment of the radio frequency, or minimum of one year, whichever is less.

ii. Upon successful processing of an application requesting for an assignment of radio frequency (RF), the applicant be informed about the License Fees and Royalty required to be deposited by him. These shall be calculated for the full period of the requested assignment. Where the period is greater than one year, the wireless user/ applicant has to pay the license fee and royalty in annual installments in advance every year.

iii. Immediately thereafter, but in no case later than thirty (30) days from the date of issue of the said letter, the applicant shall pay the charges for issue of License/ DL/ AIP, if otherwise permissible. If, on the other hand, the payment is not received within this period of 30 days, the application will be treated as ***cancelled*** and the frequencies shall be freed for being assigned to others. If the same applicant wants to subsequently pursue the application, he shall be required to submit a ***fresh*** application.

iv. The amounts due for different periods may be determined as follows.

License Period	License Fee payable	Royalty payable from the date of DL/ AIP/ WOL, as the case may be	Method of payment
One month or less	At specified flat rate.	Annual royalty divided by 12.	Full license fee & royalty to be paid in advance at the time of issue of DL/AIP/ license.
More than one month but up to one year	At specified flat rate.	On pro-rata basis. However, part of a month shall be taken as one month.	– do –
More than one year	At specified flat rate.	On pro-rata basis. However, part of a month shall be taken as one month.	Pay the L/fee plus Royalty for the entire duration in advance at issue of DL/AIP/ license, OR pay it in annual advance instalments.

v. In case the licensee defaults on one of the annual installment payments, all the remaining installments shall become immediately payable.

vi. A Licensee shall be responsible to apply for the renewal of his/ her existing frequency authorization or wireless operating license (WOL), within a period of thirty (30) days *before* the expiry of the said WOL/ AIP/ DL.

vii. **Surrender of a License/ AIP/ DL:** Spectrum charges are payable minimum for one month and thus on surrender of licenses the Royalty charges in excess of one month can be adjusted. However, any monetary refund can only be made if the payments have been received for more than one year and surrender results the Royalty charges in excess of 1 year. The word "surrender" in this paragraph shall mean surrender of a complete **License/ AIP/ DL** with all its frequency assignments.

5. **Surcharge/Late Fee for Late Renewal of Wireless Station Licenses:** Surcharge/ Late fee for delayed renewal of various licenses shall be levied on the total amount due (i.e. license fee *plus* royalty charges) @ 2% per month or part thereof, subject to the minimum of Rs. 250/- per license. In case the delay is more than one year the said late fee shall be applied in an *annually compounded* manner.

6. This issues with the concurrence of the Wireless Finance Division, vide this Dy. No.482/Sr.DDG(WPF), dated 19/3/12.

7. This Order shall come into force from 1st April 2012.

(Viresh Goel)
Deputy Wireless Advisor
to the Government of India

Copy to:

1. All concerned
2. Wireless Finance Division
3. Wireless Monitoring Organisation
4. Director, IT DoT for uploading on DoT website
5. DWA(ASMS) for uploading on WPC Wing website

LIST OF ACRONYMS

2G	Second Generation
3G	Third Generation
3GPP	3rd Generation Partnership Project
4G	Fourth Generation
5G	Fifth Generation
6G	Sixth Generation
AGR	Adjusted Gross Revenue
BCA	Band and Carrier Aggregation
BSS	Broadcasting Satellite Service
CAGR	Compound Annual Grouwth Rate
CAPEX	Capital Expenditure
DoT	Department of Telecommunications
EESS	Earth Exploration Satellite Service
EIRP	Equivalent Isotropic Radiated Power
ETSI	European Telecommunication Standards Institute
FCFS	First Come First Serve
FDD	Frequency Division Duplexing
FSS	Fixed Satellite Service
GHz	Giga Hertz
GSO	Geo Stationery Orbit
HTS	High Throughput Satellite
IAB	Integrated Access Backhaul
IEEE	Institute of Electrical and Electronics Engineers
IMT	International Mobile Telecommunications
ISP	Internet Service Provider
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union Radiocommunication
LSA	Licensed Service Area

LTE	Long Term Evolution
MGWS	Multiple Gigabit Wireless System
MHz	Mega Hertz
MoLJ	Ministry of Law and Justice
MSS	Mobile Satellite Service
MWA	Microwave Access
MWB	Microwave Backbone
NDPL	Non Dealer Possession License
NFAP	National Frequency Allocation Plan
NLD	National Long Distance
NR	New Radio
O&M	Operation And Maintenance
OEM	Original Equipment Manufacturer
OFC	Optical Fibre Cable
OPEX	Operating Expenditure
PFD	Power Flux Density
P2P	Point To Point
RAN	Radio Access Network
RF	Radio Frequency
RoW	Right of Way
RR	Radio Regulation
SACFA	Standing Advisory Committee on Frequency Allocation
SMRA	Simultaneous Multiple Rounds Ascending
SRS	Space Research Service
SUC	Spectrum Usage Charges
TDD	Time Division Duplexing
TDMA	Time Division Multiple Access
TRAI	Telecom Regulatory Authority of India
TSP	Telecom Service Provider
UASL	Unified Access Service License

UL	Unified License
VHTS	Very High Throughput Satellite
WLAN	Wireless Local Area Network
WPC	Wireless Planning and Coordination
WRC	World Radiocommunication Conference
XPIC	Cross Polarization Interference Cancellation