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भारतीय दूरसंचार विनियामक प्राधिकरण

Telecom Regulatory Authority of India

Consultation Paper on
Assignment of the Microwave Spectrum in
6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, 21 GHz Bands, E-Band, and V-Band

New Delhi, India

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Tower F, NBCC World Trade Centre, Nauroji Nagar, New Delhi-110029

Written Comments on the Consultation Paper are invited from the stakeholders by 25.06.2025 and counter-comments by 09.07.2025. The 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**.**

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Chapter I: Introduction and Background

A. Introduction

1.1 Electromagnetic spectrum refers to the range of frequencies of electromagnetic radiations[1]. Electromagnetic radiations are made up of waves of varying frequencies, which carry energy. From the lowest to the highest frequencies, the full electromagnetic spectrum comprises radio waves, infrared light, visible light, ultra-violet light, x-rays, and gamma rays. Radio spectrum refers to that part of the electromagnetic spectrum which comprises radio waves – the waves with frequencies from 3 kHz to 3,000 GHz.

1.2 Guglielmo Marconi is widely recognized as the inventor of radio[2]. On December 12, 1901, Guglielmo Marconi and his assistant, George Kemp, confirmed the reception of the first transatlantic radio signal[3]. With a telephone receiver and a wire antenna kept aloft by a kite, they heard Morse code for the letter "S" transmitted from Poldhu, Cornwall[4]. Marconi's achievement not only revolutionized telecommunications by demonstrating the possibility of transmitting information wirelessly over vast distances but also ushered in a new era of radio technology. The development of radio telegraphy led to numerous advancements in science, technology, and society.

[1] Electromagnetic radiations travel at the speed of light in a vacuum and exhibit wave–particle duality, behaving both as waves and as discrete particles called photons.

[2]Source: https://spectrum.ieee.org/who-invented-radio-guglielmo-marconi-or-aleksandr-popov

[3] The radio transmission used frequencies of around 850 kHz.
Source: Mythri Hunukumbure, Justin P. Coon, Ben Allen, and Tony Vernon (2022) The Technology and Business of Mobile Communications: An Introduction (Wiley IEEE Press)

[4]Source: https://ethw.org/Milestones:Reception_of_Transatlantic_Radio_Signals,_1901

1.3 International Telecommunication Union (ITU) has subdivided the radio spectrum[5] into the following nine frequency bands[6]:

Table 1.1: Radio Frequency Bands

Band Number[7]	**Name**	**Symbols**	**Frequency Range**	**Corresponding Metric Sub-division**
4	Very Low Frequency	VLF	3 to 30 kHz	Myriametric waves
5	Low Frequency	LF	30 to 300 kHz	Kilometric waves
6	Medium Frequency	MF	300 to 3,000 kHz	Hectometric waves
7	High Frequency	HF	3 to 30 MHz	Decametric waves
8	Very High Frequency	VHF	30 to 300 MHz	Metric waves
9	Ultra High Frequency	UHF	300 to 3,000 MHz	Decimetric waves
10	Super High Frequency	SHF	3 to 30 GHz	Centimetric waves
11	Extremely High Frequency	EHF	30 to 300 GHz	Millimetric waves
12			300 to 3,000 GHz	Decimillimetric waves

[5] Though the radio frequencies have a range from 3 kHz to 3,000 GHz, the present ITU's Radio Regulations (Edition of 2024) have allocations of radio frequencies only in the 8.3 KHz to 275 GHz range.
Source: ITU's Radio Regulations, Edition of 2024, accessible at the following URL:
https://www.itu.int/hub/publication/r-reg-rr-2024/

[6] Source: Final Acts WRC-15 World Radiocommunication Conference Geneva, 2015
Accessible at the URL: https://www.itu.int/dms_pub/itu-r/opb/act/R-ACT-WRC.12-2015-PDF-E.pdf

[7] "Band N" (N = band number) extends from 0.3×10^N Hz to 3×10^N Hz.

1.4 The earliest radio technologies depended mainly on lower frequencies (i.e., the frequencies upto 300 MHz) for two simple reasons - one relating to the state of the technological development at that time, and the other relating to propagation characteristics of lower frequencies. It was much simpler to design lower frequency communication systems with the then available electronic communication technologies. Plus, lower frequencies can travel long distances (long propagation ranges); they are not subject to weather disruptions; they also penetrate most trees and even walls. However, as the demand for wireless telecommunications grew, the limitations of lower frequencies became apparent - lower frequencies lacked on the key aspect of 'bandwidth' and thereby 'information capacity'[8]. In general, the lower the frequency, the longer the propagation range but less bandwidth as the channel widths that are available are narrower. Moving higher in frequency means shorter propagation range but higher bandwidth.

1.5 The development of radar in the Second World War stimulated the expansion of communication technologies based on the microwave spectrum[9] i.e. the range of frequencies between 300 MHz to 300 GHz (the bands numbered 9, 10, and 11 in the Table 1.1 above). The prefix "micro" in microwaves is not meant to suggest a wavelength in the micrometre range; rather, it indicates that microwaves are smaller (having shorter wavelengths), compared to the radio waves used in the earlier radio technologies. The development of microwave technologies led to the construction of several transcontinental microwave relay systems in North America and Europe after the Second World

[8] "Bandwidth" of a signal is simply the range of frequencies that the signal contains. "Information capacity" of a channel is the amount of information that can be passed through a channel in a given time period.
In 1948, Claude Shannon developed a relationship between the information capacity of a channel to the channel's bandwidth and signal to noise ratio (SNR) as below:
$I=B \log_2 (1+SNR)$
Where I= Information capacity of the channel in bits per second
B= Bandwidth of the channel in Hz
SNR = Singal to Noise Ratio
Source: https://electronx.ca/education/communications/introduction-signals/bandwidth-information-capacity/#:~:text=The%20contributing%20factors%20to%20the,Bits%20Per%20Symbol)%5B/latex%5D

[9] Source: IEEE's article on 'Role of radar in microwaves' available at https://ieeexplore.ieee.org/document/989947

War. With the passage of time, advancements in solid state technologies[10] and digital signal processing techniques[11] greatly enhanced the performance and lowered the cost of operating at microwave frequencies. These developments led to widespread usage of the microwave spectrum in wireless telecommunication systems worldwide.

B. Usage of the Microwave Spectrum in Cellular Mobile Networks

1.6 The microwave spectrum is the lifeblood of today's cellular mobile networks. It is used for providing both cellular mobile radio access and backhaul. A brief description of these terms has been included in the following section. Conventionally, the microwave spectrum ranging from 400 MHz to 4 GHz was used for providing cellular mobile radio access, while the microwave spectrum ranging from 6 GHz to 24 GHz was used for providing backhaul. However, the recent introduction of the fifth generation (5G) radio access technology[12] in telecommunication networks and the consequent need for wider frequency channels have led to the use of frequencies above 24 GHz also - for cellular mobile radio access and radio backhaul.

1.7 At the international level, ITU regulates the utilisation of radio frequencies, through Radio Regulations[13]. In the scheme of ITU Radio Regulations, the cellular mobile radio access is a part of 'mobile service' while the radio backhaul is a part of 'fixed service'[14].

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[10] Solid-state technology refers to electronic devices and systems built using semiconductors instead of traditional vacuum tubes or moving parts.

[11] Digital Signal Processing (DSP) is the manipulation of real-world signals within a digital computer, using mathematical techniques to enhance, change, or display the data in a specific way. It involves converting analog signals (such as audio or video) into digital form and performing various operations on them.
Source: https://www.sciencedirect.com/topics/physics-and-astronomy/digital-signal-processing#:~:text=Digital%20Signal%20Processing%20(DSP)%20is,%2C%20geophysics%2C%20and%20medical%20imaging

[12] 5G radio access technologies are based on the ITU's standard on International Mobile Technology (IMT)-2020.

[13] ITU's Radio Regulations, Edition of 2024 are accessible at the URL: https://www.itu.int/hub/publication/r-reg-rr-2024/. In India, the Radio Regulations (Edition of 2020) is the foundational text used for drawing up the National Frequency Allocation Plan-2022 (NFAP-2022).

[14] The Radio Regulations define the terms 'mobile service' and 'fixed service as below:

C. Backhaul

1.8 A typical public telecommunication network consists of the following components:

(a) Access network;

(b) Core network; and

(c) Backhaul links.

1.9 "Access network" is the last mile connectivity to consumer devices. "Core network"[15] connects the access network to global public networks such as public internet, PLMN and PSTN. "Backhaul links" are used to connect the access network with the core network. The following figure depicts a typical public telecommunication network.

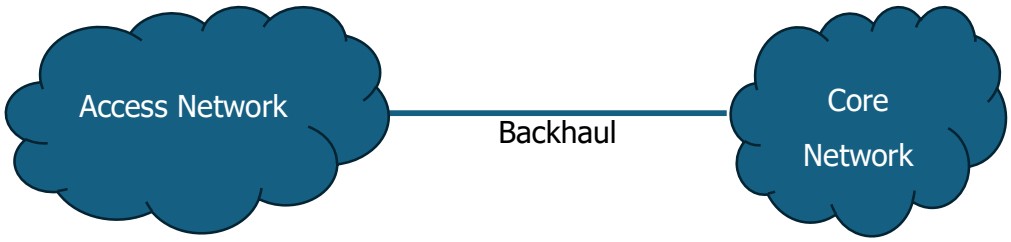

Figure 1.1: Architecture of a typical public telecommunication network

1.10 In mobile networks[16], the last mile 'access' to consumer devices is provided by using the microwave spectrum. For backhauling the telecommunication

'Mobile service': A radiocommunication service between mobile and land stations, or between mobile stations.
'fixed service': A radiocommunication service between specified fixed points.

[15] The core network carries out the switching and routing functions needed to connect a specific voice or data connection request to the correct paths.

[16] Mobile networks, as the name implies, provide the freedom of connectivity while on the move, virtually anywhere. This mobility is supported through the use of radio waves for the 'last mile of' connectivity – technically the 'air interface', between the mobiles and the base station. Although this last mile is a very fluid way for communication, a well-planned, rigid structure of radio cells needs to be in place to orchestrate this. The network of cells, activated by the base stations provide radio coverage throughout the span of the cell. In earlier cellular generations (up to 3G), there is a control node for the base stations – which decides on the attachment of a mobile to a certain base station, the process of switching the attachment (called handover) and the resource allocation to the mobiles for communication. In later standards (4G and 5G), this node has disappeared, with its functionality absorbed mainly by the base stations. The interface that connects the base stations to the controller (and to the core in 4G/ 5G) is known as the backhaul links.

traffic from access network to the core network, traditionally, copper wires were used. However, as the mobile networks gained popularity and the telecommunication traffic grew significantly, the "optical fibre cable" (OFC) emerged as the most desirable medium for backhauling as the OFC offers infinite data capacity with the highest degree of reliability. In the last two decades, the country has witnessed a significant fiberization of the backhaul links connecting the access network with the core network. However, the OFC is, at times, not a 'practical' choice for backhauling mobile traffic. There could be practical difficulties in laying the OFC in certain places such as tough terrains, hilly regions, water bodies, etc. The OFC may not be an economically viable option in sparsely populated places where the mobile traffic is not substantial. At certain places, there could be difficulties in getting permissions for laying the OFC, or Right of Way (RoW) charges for laying the OFC could be a matter of concern.

1.11 In short, though the OFC is technically the most desirable medium for mobile backhauling owing to its infinite data capacity and the highest degree of reliability, it is sometimes time-consuming and costly to lay the OFC upto the base stations[17] of cellular mobile networks. As deploying wireless links is both faster and more cost-effective, telecom service providers generally prefer to deploy backhaul links using the microwave spectrum in places where laying the OFC is difficult and/ or economically unviable[18]. A backhaul link deployed using the microwave spectrum is referred to as 'microwave backhaul link', or simply 'microwave backhaul'. Microwave backhaul systems generally use directional antennas to create a wireless point-to-point (PTP) link, which enables data (information) to be transmitted over long distances.

Source: Mythri Hunukumbure, Justin P. Coon, Ben Allen, and Tony Vernon (2022) The Technology and Business of Mobile Communications: An Introduction (Wiley IEEE Press)

[17] In cellular mobile networks, a base station is a fixed transceiver that is the main communication point for one or more mobile client devices. A base station serves as a central connection point for a mobile device to communicate.
Source: https://www.techtarget.com/whatis/definition/base-station

[18] Lately, telecom service providers have undertaken a significant densification of base stations, mainly because they have deployed higher frequency bands[18] particularly to cater to the massive increase in the mobile traffic in urban areas. At many of the new mobile base station sites in urban areas, laying OFC could be difficult and/ or economically unviable. The wireless backhaul becomes the preferred choice for telecom service providers to connect such mobile base stations.

1.12 The microwave spectrum is used not only in mobile backhaul links but also in the backbone networks[19]. In telecommunications, the backbone network is used to connect various nodes of the core network situated at different geographical locations. Though the OFC is arguably the preferred medium for connecting various nodes of the core network, telecom service providers tend to use the microwave spectrum of lower frequencies (typically less than 10 GHz)[20] to connect the nodes of the core network in case the laying of the OFC between such nodes is difficult and/ or economically unviable.

1.13 In the present consultation paper, both backhaul links and backbone links built on microwave spectrum will collectively be referred to as "microwave backhaul", or "radio backhaul", or "wireless backhaul".

1.14 As per the report[21] by GSMA and ABI Research on 'Wireless Backhaul Evolution' (2021), the wireless backhaul will account for the majority of global backhaul links from 2021 to 2027 with around 65% market share; however, the continued use of the 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 for this purpose. 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 report also mentions that the traditional microwave bands (6 GHz to 42 GHz) would continue to have an important role to play as they can cover longer distances with fewer hops.

1.15 The following figure depicts the spectrum bands which are being used or are being considered in the near future for the microwave backhaul.

[19] Source: DoT's web-page on microwave links, accessible at https://eservices.dot.gov.in/network-microwave-link

[20] The lower frequencies can support longer links. Therefore, lower microwave frequencies are preferred in backbone networks.

[21] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

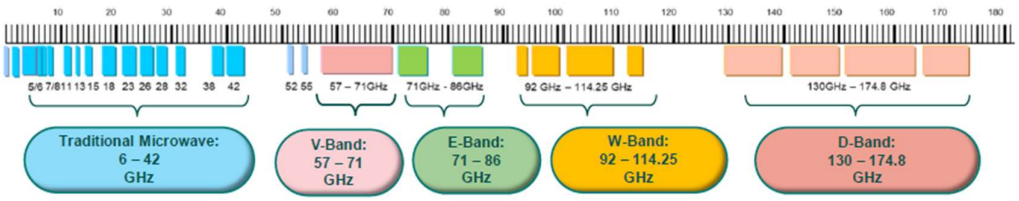

Figure 1.2: Spectrum bands being used or under consideration for the microwave backhaul, Source: ITU

1.16 Ericsson, in its report on Microwave Outlook (2022)[22], has mentioned that there are around 10 million transceivers installed for the microwave backhaul around the world and new deployments in the traditional bands (6 GHz to 42 GHz) remain the backbone for the microwave backhaul. The following figure depicts the regional usage of the microwave spectrum, where the size of each circle represents the installed base and new deployment share per frequency range.

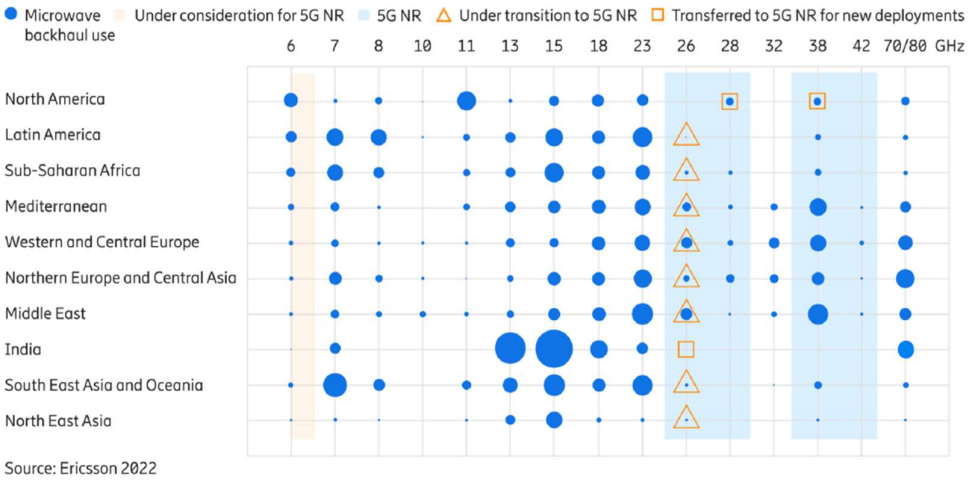

Figure 1.3: Regional usage of the microwave spectrum[23]

1.17 Various technologies, which are available today for backhauling the telecommunication traffic, have their unique strengths and weaknesses. GSMA

[22] Source: Ericsson Microwave Outlook, October 2022. The report is accessible at the following URL: https://www.ericsson.com/4a81b8/assets/local/reports-papers/microwave-outlook/2022/ericsson-microwave-outlook-report-2022.pdf

[23] ibid

in its report on 'Mobile Backhaul Options' (2018) has provided a comparison of various means of backhaul technologies as below:

Table 1.2: Various Mobile Backhaul Technologies[24], Source: GSMA

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

1.18 Amongst all the options for backhauling the telecommunication traffic, the OFC scores the most on all parameters except 'deployment cost' and 'time to deploy'. Importantly, it is a future-proof technology. Considering the strengths of the OFC as a medium for backhauling, there has been a consistent endeavor on the part of both the Government and service providers to enhance the fiberization of telecom towers. The National Broadband Mission[25] released by DoT in December 2019, envisaged to increase by around two and half times

[24] GSMA Report - 'Mobile backhaul options - Spectrum analysis and recommendations', September 2018 accessible at https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2019/04/Mobile-Backhaul-Options.pdf

[25] https://dot.gov.in/sites/default/files/National%20Broadband%20Mission%20-%20Booklet_0.pdf

the number of fiberized telecom towers in the country. The National Broadband Mission, 2019 had set the five-year target as below:

Table 1.3: Target of Fiberization of Telecom Towers

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

1.19 As per the press release dated 22.07.2022[26] issued by the Ministry of Communications on the progress of the National Broadband Mission, "*approximately 35.11% of Telecom Towers/ BTSs are fiberized as on June 2022. It is envisaged to be increased up to 70% by 2024-25.*"

1.20 In the recent past, the Government of India has taken many initiatives to facilitate the fiberization of telecom towers. For instance, the Government in May 2022 launched the Gati Shakti Sanchar Portal for streamlining Right of Way (RoW) permissions for quick OFC laying and telecom tower setup, reducing the approval time. Besides, the Government, through the Telecommunications (Right of Way) Rules 2024, introduced uniform RoW charges nationwide for expediting telecom infrastructure deployment. Telecom service providers have also made significant investments to increase the fiberization of telecom towers. However, beginning from the year 2022, telecom service providers in India have started rolling out 5G mobile networks at a rapid pace (in addition to the regular expansion of the existing 4G and 2G mobile networks). The introduction of 5G mobile networks and the consequent use of higher frequency bands in radio access networks have led to a significant densification of base stations, particularly in urban areas. As the microwave backhaul is both faster to deploy and more cost effective, there has been a natural tendency amongst telecom service providers to connect

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

new base stations (on many of them laying the OFC could be difficult and/ or economically unviable) by using the microwave spectrum. As a result, while the total number of fiberized base stations in the country has increased with the passage of time, the percentage fiberization of cellular mobile base stations has been able to reach only about 46%[27], demonstrating the continued need for the microwave backhaul in telecommunication networks.

D. Architecture of the Backhaul in Mobile Networks

1.21 Owing to the techno-commercial considerations, the backhaul of mobile networks in India contains a mix of OFC and microwave backhaul. The typical architecture of the backhaul in mobile networks in the country can be visualized as a two-part system comprising of "pre-aggregation part"[28] and "aggregation part" as outlined below:

(a) Pre-aggregation part of the backhaul: It connects cellular mobile base stations with the aggregation point.

(b) Aggregation part of the backhaul: It connects the aggregation points to the core network. In effect, it carries the aggregated traffic from the cellular mobile base stations to the core network.

1.22 The following figure depicts a typical architecture of the backhaul in mobile networks in India:

[27] As of March 2025, 46.09% of BTSs (base stations) were fiberized. Source: DoT

[28] The pre-aggregation of the backhaul is also referred to as "the last leg" or "the last mile" of the backhaul.

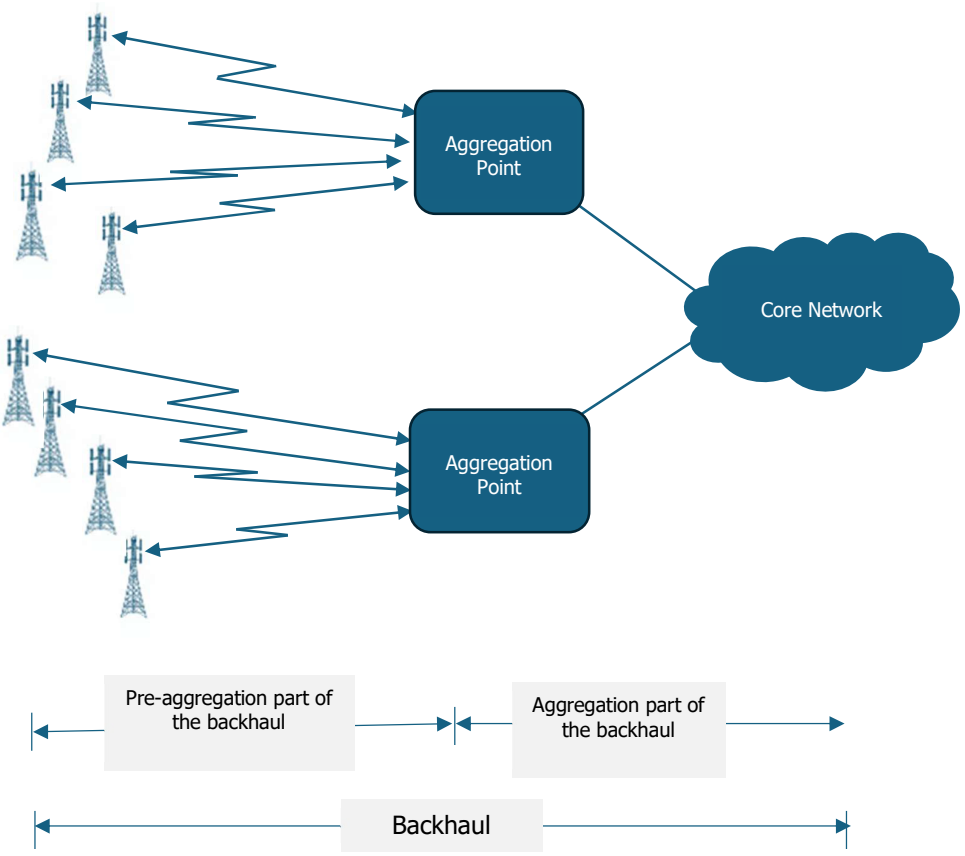

Figure 1.4: Typical architecture of the backhaul of mobile networks

1.23 As the aggregation part of the backhaul requires high data capacity, it is, generally, built by using the OFC[29]. On the other hand, the pre-aggregation part of the backhaul is built by using microwave backhaul, or OFC[30]. As mentioned earlier in this chapter, about 46% of cellular mobile base stations in the country have been fiberized; meaning thereby, about 54% of cellular mobile base stations are connected to aggregation points[31] through the microwave spectrum.

[29] The OFC has infinite data capacity and the highest degree of reliability.

[30] In some cases, the satellite connectivity is also used, particularly to connect the cellular mobile base stations in remote and far-flung areas.

[31] In rare cases, cellular mobile base stations could be connected to the core network directly through the microwave spectrum.

E. Traditional Microwave Backhaul Bands

1.24 In India, prior to the introduction of 5G mobile networks, only the spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands were used for providing the microwave backhaul. These bands are often referred to as "the traditional microwave backhaul bands". DoT has classified the traditional microwave backhaul bands into two categories viz. Microwave Access (MWA) bands and Microwave Backbone (MWB)[32] bands. A brief description of MWA bands and MWB bands is given below:

(a) MWA bands: In India, 13 GHz band (12.75-13.25 GHz), 15 GHz band (14.5-15.5 GHz), 18 GHz band (17.7-19.7 GHz,) and 21 GHz band (21.2-23.6 GHz) are collectively referred to as "MWA bands". The spectrum in MWA bands is used to carry traffic over relatively shorter distances.

(b) MWB bands: Lower 6 GHz (5.925-6.425 GHz) and 7 GHz (7.125-7.725 GHz) bands are collectively referred to as "MWB bands". The spectrum in MWB bands is used to carry traffic over relatively longer distances.

F. TRAI's Earlier Recommendations on 'Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF Carriers' dated 29.08.2014

1.25 In the year 2012, Department of Telecommunications (DoT), Ministry of Communications, Government of India, through a reference dated 26.11.2012 under Section 11(1)(a) of the TRAI Act, 1997, had requested Telecom Regulatory Authority of India (hereinafter, also referred to as "TRAI", or "the Authority") to provide recommendations on the following aspects:

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.

[32] Source: https://saralsanchar.gov.in/circular/licenses_issued/FAQ_ISP_MWA.pdf

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.

1.26 In response, TRAI, on 29.08.2014, sent its recommendations on 'Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers' (hereinafter, also referred to as "the Recommendations dated 29.08.2014") to DoT. The Recommendations dated 29.08.2014 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 In 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 The assignment of MWA carriers should be done on an exclusive basis for the various spectrum bands in 13-42 GHz range whereas the assignment of MWB carriers should be done on a link-to-link basis. (Para 2.58)

5.6 The assignment of MWA and MWB carriers should continue to be done administratively. (Para 2.62)

5.7 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 The 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)

5.9 a) The Central Government should take up the issue of RoW with the State Governments on top priority to emphasise the need to bring simplification and uniformity in the process of according RoW permissions and to bring the RoW charges to a realistic level.
b) The Central Government may mandate various agencies, responsible for making intra- and inter-city roads/ highways, to provide infrastructure utility ducts along the roads/ highways which can be used by companies providing utility services like telecom, power etc. for laying cables. (Para 3.9)

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

5.11 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. (Para 3.25)

5.12 The 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 If 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 Spectrum charges for MWB link shall be Rs. 13,900 per KM per annum. (Para 3.57)

5.15 Present 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)

5.16 In order to increase broadband penetration in India, the usage of high capacity backhaul E-band (71-76 / 81-86 GHz) and V-band (57-64 MHz) may be explored for allocation to the telecom service providers. (Para 4.17)

5.17 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. (Para 4.31)

5.18 (a) Channel bandwidth for E-band (71-76 GHz and 81-86 GHz) should be 250 MHz with a guard band of 125 MHz at the top and bottom of each 5 GHz band. More than one channel can be allowed and allocated for aggregation.
(b) Channel bandwidth for V-band (57-64 GHz) should be 50 MHz with a 100 MHz guard band at the beginning of the band. More than one channel can be allowed and allocated for aggregation. (Para 4.37)

5.19 (a) 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.

(b) 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 50 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.

(c) 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.

(d) The prices mentioned for E-band and V-band has to be reviewed after 5 years based on deployment and usage of the links. (Para 4.50)

1.27 DoT, through the Reference dated 12.08.2022 (outlined in the next section), informed that "*it has been decided to seek fresh recommendation of TRAI… in view of technological changes which have taken place over the years…*" on the matter.

G. DoT's Reference Dated 12.08.2022

1.28 Through the letter dated 12.08.2022 (**Annexure-1.1**), DoT sent a reference under Section 11(1)(a) of the TRAI Act, 1997 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" (hereinafter, also referred to as "the Reference dated 12.08.2022") to TRAI. An extract from the Reference 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."

1.29 In this regard, TRAI, through a letter dated 09.09.2022, sought certain 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.

1.30 With respect to the Reference dated 12.08.2022, TRAI issued a consultation paper on 'Assignment of Spectrum in E&V Bands, and Spectrum for Microwave Access (MWA) & Microwave Backbone (MWB)' dated 27.09.2023[33] (hereinafter, also referred to as, "the Consultation Paper dated 27.09.2023") for soliciting comments of stakeholders. Initially, the last dates for the submission of comments and counter-comments on the Consultation Paper dated 27.09.2023 were fixed as 25.10.2023 and 08.11.2023, respectively. However, considering requests from a few stakeholders, the last dates for the submission of comments and counter-comments were extended on three occasions and four occasions, respectively. After extensions, the last dates for the submission of comments and counter-comments were kept as 13.12.2023 and 03.01.2024, respectively. In response to the Consultation Paper dated 27.09.2023, TRAI received comments from 23 stakeholders, and counter-comments from six stakeholders. The comments and counter-comments received from stakeholders in response to the Consultation Paper dated 27.09.2023 are available on TRAI's website[34].

1.31 In the meanwhile, in December 2023, the Indian Parliament enacted a new statute namely, 'the Telecommunications Act, 2023'[35]. The Act amends and consolidates the law relating to development, expansion and operation of telecommunication services and telecommunication networks, assignment of spectrum, and for matters connected therewith or incidental thereto. Section 4(4) of the Telecommunications Act, 2023 provides as below:

[33] The Consultation Paper dated 27.09.2023 is available on the TRAI's website at the following URL: https://www.trai.gov.in/sites/default/files/2024-09/Consultation_Paper_27092023.pdf

[34] The comments and counter-comments may be accessed at the following URL: https://trai.gov.in/consultation-paper-assignment-spectrum-ev-bands-and-spectrum-microwave-access-mwa-microwave

[35] Source: https://egazette.gov.in/WriteReadData/2023/250880.pdf

"The Central Government shall assign spectrum for telecommunication through auction except for entries listed in the First Schedule for which assignment shall be done by administrative process."

Explanation. – For the purposes of this sub-section,-

(a) "administrative process" means assignment of spectrum without holding an auction;

(b) "auction" means a bid process for assignment of spectrum."

1.32 The First Schedule of the Telecommunications Act, 2023 lists 19 items for the assignment of spectrum through administrative process. The relevant items of the First Schedule are reproduced below:

"12. Radio backhaul for telecommunication services.

Explanation.—The term "radio backhaul" shall mean the use of radio frequency only to interconnect telecommunication equipment, other than the customer equipment in telecommunication networks."

1.33 In view of the afore-mentioned provision of the Telecommunications Act, 2023, TRAI, through a letter dated 20.02.2024, conveyed to DoT that *"the DoT's Reference dated 12.08.2022, requesting TRAI to provide its recommendations for (a) methodology of auction of E&V band spectrum and (b) allocation methodology of MWA and MWB RF carriers in 6/7/13/15/18/21 GHz bands, may require a review by DoT. Therefore, DoT is requested to provide the specific issues on which TRAI's recommendations are now required on the subject."*

H. DoT's Instant Reference Dated 13.09.2024

1.34 In response to TRAI's letter dated 20.02.2024, DoT sent a letter dated 13.09.2024 (**Annexure 1.2**) to TRAI. Through the letter dated 13.09.2024, DoT provided a clarification to TRAI's query and requested TRAI to provide its recommendations under Section 11(1)(a) of the TRAI Act, 1997 on certain aspects. Hereinafter, the DoT's letter dated 13.09.2024 will be referred to as

"the Reference dated 13.09.2024". The relevant extract of the Reference dated 13.09.2204 is reproduced below:

"… TRAI, quoting the provisions of Section 4(4) and the First Schedule of the Telecommunications Act, 2023, has mentioned that DoT's reference dated 12-08-2022 may require review in respect of the item (a) and (b) of the reference i.e., methodology of allocation (auction) and requested to provide specific issues on which their recommendations would now be required.

2. While agreeing to the TRAI's observation that Backhaul spectrum is part of First Schedule of the Act, for which the assignment method would be administrative, it is to state that DoT's letter dated 12-08-2022 on the 6/7/13/15/18/21 GHz bands was based upon techno-regulatory state at that point of time. Meanwhile, apart from passing of the Telecommunications Act, international regulatory landscape has seen some changes at the World Radiocommunications Conference (WRC) 2023. The Telecom Service Providers (TSPs) have also demanded amended usage of some of these bands. Without going into the merit of these demands, these are mentioned in the developments below:

2.1 6 GHz: While the upper 6 GHz band (not part of this reference) i.e., 6.425-7.125 GHz has been identified for IMT in other parts of the world, the lower 6 GHz band i.e. 5.925 to 6.425 GHz continues to be used as backhaul.

2.2 7/ 13/ 15/ 18/ 21 GHz: The spectrum band 7.125 to 8.400 GHz (7 GHz) & 14.8-15.35 GHz (15 GHz) are being considered for IMT i.e., Access, under agenda items 1.7 of WRC-2027. One of commercial telecom service providers holding Unified License with Access service authorisation and providing wireline services has requested for spectrum in the 6/ 7/ 13 GHz bands for establishing links for last mile connectivity solutions in certain Licensed Service Areas.

2.3 Requirement of captive users: Point to point connectivity requirements of certain captive users is required to be met from one or more of these bands

i.e. 6/ 7/ 13/ 15/ 18/ 21 GHz bands. Such requirements are generally localised and mostly limited to few links only. In case, some carriers are specifically earmarked for such use, they can be re-used among multiple users with geographical separation.

It may be noted that current use of 6 GHz (lower)/ 7/ 13/ 15/ 18/ 21 GHz for backhaul purposes continues to be covered under the First Schedule of the Act.

3. The Developments related to V- band and E- band are described below:

3.1 The V-band (57-64/ 66 GHz) is a part of the band n263 of 3GPP (57 GHz to 71 GHz), which is also referred to as 60 GHz band. That is to say that the complete 57-71 GHz band has been planned by 3GPP as IMT/ Access band. Point to point (backhaul) solutions are also available in the V band. Further, a part of this band, i.e., 66-71 GHz, has already been identified by ITU globally for IMT based Access services in WRC-19.

3.2 The E-Band (71-76 GHz/ 81-86 GHz) has already been assigned LSA-wise for Backhaul purpose to TSPs on provisional basis, during 2022. One of the commercial telecom service providers, holding UL with Access service authorisation, has sought permission for using this band for Access Services, in addition to the Backhaul purposes. i.e. as IAB (Integrated Access & Backhaul). In addition, another service provider, holding UL with Internet service authorisation (ISP) has sought E/ V band spectrum for last mile connectivity purpose.

4. In view of above, TRAI, considering the relevant clauses of section 4 of the Telecommunications Act, 2023, is requested to provide its recommendations under section 11(1) (a) of the TRAI Act on the following:

(a) Demand assessment and scope of service/ usage for (i) 57-64/ 66 GHz (V-band) and (ii) 71-76 GHz/ 81-86 GHz (E-band) and accordingly methodology of assignment of spectrum and associated terms & conditions, in line with the

determination of scope of services/ usages by TRAI i.e. "Access" or "Backhaul" or "Integrated Access & Backhaul (IAB)".

(b) Spectrum charges and related terms & conditions such as spectrum cap, carrier aggregation, etc. for assignment of spectrum in 6 (lower)/ 7/ 15/ 13/ 18/ 21 GHz bands for backhaul purposes of commercial telecom services.

(c) Any need for review in respect of use of 7/ 15 GHz bands in view of consideration of these bands for Access using IMT after WRC - 2027.

(d) Quantum/ band(s) of spectrum to be earmarked for last mile connectivity (Fixed Wireless Access) of commercial telecom services and methodology of assignment of spectrum and associated terms & conditions in non-IMT bands as referred to in Para 2.2 above.

(e) Quantum/ band(s) of spectrum to be earmarked for Backhaul purposes for noncommercial/ captive use and associated terms & conditions including charges as referred to in Para 2.3 above.

(f) Feasibility & technical parameters, for allowing low power, indoor, consumer device-to-consumer device usage on license-exempt basis in V-band as referred to in Para 4(d) of reference dated 12-08-2022.

(g) Provide any other recommendations deemed fit for the purposes mentioned under (a) to (f) above."

1.35 In this regard, TRAI, through a letter dated 07.04.2025, sought additional information/ clarification from DoT. In response, DoT, through a letter dated 08.05.2025, provided the requisite information on the frequency assignments to various telecom service providers and other entities in the frequency bands under consideration. Through the letter dated 08.05.2025, DoT also informed that it "*has decided to de-license the lower 6 GHz band (5925-6425 MHz) for low power applications. Relevant rules are under consideration in the Department for notification*."

1.36 Upon careful perusal, the Authority noted that the scope of the Reference dated 13.09.2024 is quite different from the Reference dated 12.08.2022, which

necessitates a fresh consultation with stakeholders. The differences have been highlighted in the table given below:

Topic	**Scope of the Reference dated 12.08.2022**	**Scope of the Reference dated 13.09.2024**
Microwave bands (6/7/13/15/ 18/21 GHz)	**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.**	- **Spectrum charges and related terms & conditions such as spectrum cap, carrier aggregation, etc.** for assignment of spectrum in 6 (lower)/ 7/ 13/ 15/ 18/ 21 GHz bands **for backhaul purposes of commercial telecom services** - **Any need for review in respect of use of 7/15 GHz bands in view of consideration of these bands for Access using IMT after WRC - 2027**. - **Quantum/ band(s) of spectrum to be earmarked for last mile connectivity (Fixed Wireless Access)** of commercial telecom services and methodology of assignment of spectrum

Topic	Scope of the Reference dated 12.08.2022	Scope of the Reference dated 13.09.2024
		and associated terms & conditions in non-IMT bands. - **Quantum/ band(s) of spectrum to be earmarked for backhaul purposes for non-commercial/ captive use** and associated terms & conditions including charges
E-band & V-band	- 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/V band spectrum for establishment of terrestrial and/ or satellite-based telecom networks** - **Quantum of spectrum to be earmarked for non-commercial/ captive/ isolated** use in E and V bands; and methodology of assignment, **where**	- **Demand assessment and scope of service/usage** for (i) 57-64/ **66** GHz (V-band) and (ii) 71-76 GHz/ 81-86 GHz (E-band) and **accordingly methodology of assignment of spectrum and associated terms & conditions, in line with the determination of scope of services/ usages** by TRAI i.e. "Access" or "Backhaul" or "Integrated Access & Backhaul (IAB)". - Feasibility and technical parameters, for allowing low power, indoor, consumer device-to-

Topic	Scope of the Reference dated 12.08.2022	Scope of the Reference dated 13.09.2024
	auction is not feasible and pricing for the same. - 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	consumer device usages on license-exempt basis, in parallel to the licensed spectrum in part or full V band.

I. The Present Consultation Paper

1.37 In this background, this consultation paper has been prepared for soliciting comments from stakeholders on several issues related to the assignment of the microwave spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, 21 GHz Bands, E-Band, and V-Band. This chapter provides an introduction and background of the subject matter. Chapter II deals with the issues relating to the assignment of the spectrum in traditional microwave backhaul bands. Chapter III deals with the issues relating to the assignment of spectrum in E-Band and V-band. Chapter IV deals with the issues relating to spectrum charges and valuation of microwave spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, 21 GHz bands, E-band, and V-band. Chapter V summarizes the issues for consultation.

Chapter II: Issues Related to Assignment of the Spectrum in Traditional Microwave Backhaul Bands

2.1 This chapter deals with the issues relating to the assignment of the spectrum in traditional microwave backhaul bands viz. 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands.

2.2 In respect of the frequency spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands, DoT, through the Reference dated 13.09.2024, has requested TRAI to provide recommendations on the following aspects:

(a) Spectrum charges and related terms & conditions such as spectrum cap, carrier aggregation, etc. for the assignment of the spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands for backhaul purposes of commercial telecom services;

(b) Need for a review in respect of the use of 7 GHz and 15 GHz bands in view of consideration of these bands for Access using IMT after WRC-27;

(c) Quantum and band(s) of spectrum to be earmarked for the last mile connectivity (Fixed Wireless Access) of commercial telecom services and methodology of assignment of spectrum and associated terms & conditions in non-IMT bands;

(d) Quantum and band(s) of spectrum to be earmarked for backhaul purposes for non-commercial/ captive use and associated terms & conditions; and

(e) Any other recommendations deemed fit for the purposes mentioned above.

2.3 Section 4(4) of the Telecommunications Act, 2023 states that *the Central Government shall assign spectrum for telecommunication through auction except for entries listed in the First Schedule for which assignment shall be*

done by administrative process. The First Schedule of the Telecommunications Act, 2023 lists 19 items for the assignment of spectrum through the administrative process. The item at Serial No. 12 of the First Schedule is "*Radio backhaul for telecommunication services".* Meaning thereby, the spectrum for radio backhaul purposes shall be assigned through the administrative process.[36] Notably, in the explanation under the item at Serial No. 12, the term 'radio backhaul' has been defined as "*the use of radio frequency only to interconnect telecommunication equipment, other than the customer equipment in telecommunication networks".*

A. Assignment of Spectrum in Traditional Microwave Backhaul Bands for Radio Backhaul of Commercial Telecommunication Services

2.4 The Government has been assigning the spectrum in traditional microwave backhaul bands to access service providers since 1995 when cellular mobile networks were established in the country for the first time. In the early stage of the growth of cellular mobile networks in India, the spectrum in traditional microwave backhaul bands was assigned to access service providers in the paired blocks of 3.5 MHz, 7 MHz, and 14 MHz. However, as the demand for the radio backhaul increased with the growth in cellular mobile traffic in the country, the paired block size was increased to 28 MHz. At present, the Government generally assigns the spectrum in traditional microwave backhaul bands in a carrier size of 28 MHz (paired)[37]. In other words, the unit of assignment for the spectrum in traditional microwave backhaul bands is generally 28 MHz (FDD)[38] i.e. 28 MHz (uplink) + 28 MHz (downlink).

[36] DoT, through the Reference dated 13.09.2024 has agreed with the TRAI's observation that the backhaul spectrum is part of the First Schedule of the Act, for which the assignment method would be administrative.

[37] While the paired block size of 28 MHz is generally used, DoT has assigned carriers in traditional microwave backhaul bands to captive users and NLD service providers in paired blocks of sizes 3 MHz, 3.5 MHz, 6 MHz, 7 MHz, 14 MHz and 35 MHz also. However, such assignments are very few in number. Source: DoT's letter dated 08.05.2025

[38] The term "FDD" is an acronym of "Frequency Division Duplexing". FDD technique allows uplink and downlink transmission at the same time, but over different frequency bands.
Source: https://www.sciencedirect.com/topics/engineering/frequency-division-duplexing

2.5 At present, the (provisional) assignment of the spectrum in traditional microwave bands to telecom service providers with Access Service authorization (hereinafter, also referred to as "access service providers") is governed by the DoT's guidelines dated 16.10.2015[39] read with the addendum dated 25.07.2022[40] to the DoT's guidelines[41]. The salient features of the DoT's guidelines dated 16.10.2015 (as amended) are given below:

(a) For MWA, a maximum of eight carriers in Metro & Category-A Service Areas and six carriers in Category-B and Category-C Service Areas[42] may be allotted to an access service provider in a licensed service area (LSA)[43].

(b) For MWB, carriers are allotted on a link-to-link basis.

(c) Each microwave carrier refers to 28 MHz paired bandwidth in 13 GHz, 15 GHz, 18 GHz and 21 GHz bands for MWA and in sub-10 GHz bands for MWB.

(1) Broad Framework for Assignment of Spectrum in Traditional Microwave Backhaul Bands

2.6 At present, MWA carriers are assigned to access service providers on a block-basis in LSA. Meaning thereby, if an MWA carrier is assigned to an access service provider in an LSA, the access service provider can use that MWA carrier on any number of radio backhaul links within the LSA. On the other

[39] DoT's Guidelines dated 16.10.2015 are accessible at the following URL:
https://dot.gov.in/sites/default/files/Guidelines%20Dated%2016th%20October%202015%20for%20Interim%20allotment%20of%20MWA%20and%20MWB%20Carriers%20.pdf

[40] The addendum dated 25.07.2022 to the Guidelines dated 16.10.2015 is accessible at the following URL:
https://dot.gov.in/sites/default/files/addendum%20to%20MW%20guidelines%20dated%2025_07_2022%20signed.pdf

[41] It is worth mentioning that the assignment of MWA/ MWB spectrum through these guidelines is provisional. The opening paragraph of the guidelines reads as below:
"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." (Emphasis supplied)

[42] Service Areas of Category-Metro Service Area: Delhi, Kolkata and Mumbai
Service Areas of Category-A Telecom Circle: Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamilnadu
Service Areas of Category-B Telecom Circle: Haryana, Kerala, Madhya Pradesh, Punjab, Rajasthan, UP (East), UP (West) and West Bengal
Service Areas of Category-C Telecom Circle: Assam, Bihar, Himachal Pradesh, Jammu & Kashmir, North East and Odisha

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

hand, MWB carriers are assigned to access service providers on a point-to-point link basis. Meaning thereby, if an MWB carrier is assigned to an access service provider for a point-to-point backhaul link between two designated points in an LSA, the access service provider cannot use that MWB carrier on any other radio backhaul link in the LSA without obtaining prior permission from DoT; such an MWB carrier can also be assigned by DoT to other telecom service providers (TSPs) and other entities (i.e. non-TSP isolated captive users) for establishing point-to-point backhaul links elsewhere in the LSA. It is worth noting that, at present, DoT assigns MWA and MWB carriers to (a) TSPs other than access service providers, and (b) other entities i.e., non-TSP isolated captive users only on a point-to-point link basis.

2.7 Based on the TRAI's request, DoT, through a letter dated 11.10.2022, provided details of carriers in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands (**Annexure-2.1)**. The details provided by DoT have been summarized in the following table:

Table 2.1: Details of Traditional Microwave Backhaul Bands

MWA/ MWB	Band	Frequency range	No. of carriers	Adjacent channel separation	Tx-Rx separation
MWB	6 GHz (lower)	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

2.8 GSMA and ABI Research, in their joint report[44] on 'Wireless Backhaul Evolution' (2021), have provided international perspective on the nature of assignment of the backhaul spectrum as below:

"Wireless backhaul bands are made available through a variety of licensing regimes; most commonly per link and block licenses, and, to a lesser extent, unlicensed, shared, and lightly licensed. Hybrid approaches allow a band to be reserved on a block basis, but operators have the flexibility to self-coordinate within the block on a per link basis. This helps manage costs and helps coordinate with other users in adjacent bands."

2.9 The report of GSMA and ABI Research also states that the "*conventional link-by-link coordination, made by an administration's regulation, is currently the most popular method for PTP[45] networks, accounting for about 45% of the countries surveyed. Interference checks are included under the administration's responsibilities*". The report provides the following composition of licensing models used internationally for microwave backhaul bands in the year 2020.

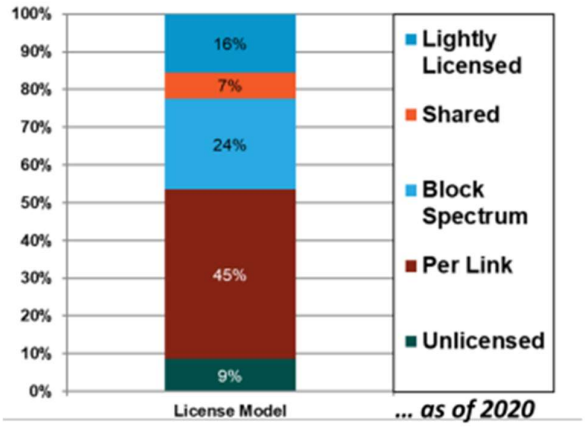

Figure 2.1: Composition of licensing models for the microwave backhaul[46]

[44] Source: https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

[45] "PTP" is an acronym of the term "point-to-point".

[46] Source: https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

2.10 The report of GSMA and ABI Research mentions that "*there is increasing interest in "hybrid licensing schemes" that combine the features of block and per link licensing. This type of licensing enables the protection of large up-front investments from block licensing, while also avoiding the spectral usage inefficiencies of per link licensing*."

2.11 The requirement of the microwave backhaul spectrum varies vastly from one telecommunication service to another. For instance, the requirement of spectrum in MWA bands is much greater for the cellular mobile service as compared to the national long distance (NLD) service. Therefore, *prima facie*, it may not be appropriate to adopt a single method (such as block-basis in LSA, link-basis, or any other) for the assignment of the microwave backhaul spectrum for all commercial telecommunication services. To further illustrate the point, suppose a telecom service provider (TSP) requires only a few links in an LSA, the assignment of the backhaul spectrum on a block-basis in the LSA to such a TSP may result in (a) an inefficient utilization of the backhaul spectrum, and (b) cost inefficiency to the TSP in case the block-based assignment is more expensive than the link-based assignment.

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

Issues for Consultation:

Q1. What is the level of demand of the spectrum in the traditional microwave backhaul bands [viz. 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands] for radio backhaul purposes? Kindly provide a detailed response with justifications.

Q2. For which commercial telecommunication services should the spectrum in traditional microwave backhaul bands be assigned

for radio backhaul purposes? Kindly provide a detailed response with justifications.

Q3. Which of the following methods should be used for the assignment of the spectrum in traditional microwave backhaul bands for radio backhaul purposes for various commercial telecommunication services:

(a) Block-basis in LSA,

(b) Point-to-point link-basis, or

(c) Any other?

Please provide a detailed response with justifications in respect of the relevant commercial telecommunication services.

Q4. In case it is decided to use different methods (block-based, link-based, or any other) for the assignment of the spectrum in traditional microwave backhaul bands for radio backhaul purposes for different types of commercial telecommunication services, what quantum of spectrum, and in which of 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands should be earmarked for point-to-point link-based assignments? Kindly provide a detailed response with justifications.

(2) Carrier Size of the Spectrum

2.13 The report[47] of GSMA and ABI Research on 'Wireless Backhaul Evolution' (2021) mentions that "*traditional microwave bands 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*

[47] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

permit operators to aggregate spectrum in these bands." The report also provides a table representing the evolution of channel sizes from 2020 to 2027 and the corresponding theoretical data throughput from the widened channels. A relevant extract from the table provided in the report is given below:

Table 2.2: Evolution of channel sizes from 2020 to 2027 in the Traditional Microwave Backhaul Bands[48]

Backhaul Band	2020		2027	
	Typical Channel Size (MHz)	Data Throughput (Gbps)	Typical Channel Size (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

2.14 As mentioned earlier in this chapter, the present carrier size of the traditional microwave backhaul spectrum in India is generally 28 MHz (paired). Telecom service providers can acquire one or more carriers (within the prescribed ceilings) to meet their backhaul requirements. In case a telecom service provider acquires multiple carriers to meet high-capacity requirements, it can use a wider channel if the carriers, assigned to it, are contiguous. Considering that the requirement of the backhaul spectrum has increased with the introduction of 4G and 5G networks in the country over the years, one approach could be to increase the carrier size of the spectrum in traditional microwave bands. However, one may argue that the present carrier size of 28 MHz (paired) provides greater flexibility to TSPs to obtain one or more carriers to cater to their backhaul requirements and, if required, to aggregate multiple

[48] Extracted from Figure 23 of the report of GSMA and ABI Research on 'Wireless Backhaul Evolution' (2021) accessible at https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

carriers and form wider channels. At this stage, it appears *prima facie* desirable that if a TSP acquires more than one carrier in a traditional microwave backhaul band, all the carriers are assigned to it in a contiguous manner to enable the use of wider channels, if the need arises.

2.15 The Authority notes that often the radio equipment available in the market for establishing point-to-point links in any traditional microwave backhaul band do not support the entire frequency band but only a portion of the frequency band (also referred to as a 'sub-band'). If a TSP acquires more than one carrier in a particular traditional microwave backhaul band, *prima facie*, it appears desirable that all carriers in the frequency band are assigned to it within that portion of the frequency band, which may be catered by a single radio equipment.

(3) Ceiling on the Number of Carriers

2.16 The Authority perused the information provided by DoT through its letter dated 08.05.2025 on the frequency-wise spectrum assigned by DoT to access service providers in traditional microwave backhaul bands. A summary of the information is given in the following two paragraphs:

2.17 Extent of utilization of carriers in MWA bands: Amongst all MWA bands, the 15 GHz band is the most utilized band. In the 13 GHz band, generally three to four carriers out of eight carriers have been assigned to access service providers. The 18 GHz band, in which there are a total of 32 carriers, is a much less utilized band. The 21 GHz band, in which there are a total of 40 carriers, is the least utilized MWA band. The following table presents the LSA-wise assignment of MWA carriers to access service providers:

Table 2.3: MWA Carriers Assigned to Access Service Providers

LSA	13 GHz Band (Total No. of Carriers = 8)	15 GHz Band (Total No. of Carriers = 15)	18 GHz Band (Total No. of Carriers = 32)	21 GHz Band (Total No. of Carriers = 40)
Andhra Pradesh	4	11	5	1
Assam	3	11	3	1
Bihar	3	13	2	-
Delhi	4	10	8	4
Gujarat	5	14	3	-
Haryana	3	10	3	-
Himachal Pradesh	5	11	-	-
Jammu and Kashmir	3	8	4	1
Karnataka	4	15	5	2
Kerala	3	12	5	3
Kolkata	-	14	10	1
Madhya Pradesh	3	14	2	-
Mumbai	4	7	10	7
Maharashtra	2	12	6	-
North East	3	9	3	1
Odisha	3	11	4	-
Punjab	3	14	3	1
Rajasthan	3	13	5	-
Tamil Nadu	4	12	5	2
Uttar Pradesh (East)	5	10	4	-
Uttar Pradesh (West)	5	13	5	-
West Bengal	3	12	5	-

2.18 Extent of utilization of carriers in MWB bands: There is only a moderate utilization of the 6 GHz band in the country. Point-to-point links in only three out of eight carriers in the 6 GHz band have been assigned to access service providers. In the 7125-7425 MHz range (the first half of the 7 GHz band), no

assignment has been made in 11 LSAs. In the remaining 11 LSAs, only one carrier out of five carriers has been assigned to access service providers. Thus, at present, the first half of the 7 GHz band is largely unutilized. In the 7425-7725 MHz frequency range (the second half of the 7 GHz band), no assignment has been made in 8 LSAs. In 6 LSAs, only one carrier out of five carriers has been assigned. In the remaining 10 LSAs, two to four carriers have been assigned. Thus, at present, the second half of the 7 GHz band is being utilized scantily.

2.19 The Authority notes that, at present, the Government has prescribed a ceiling on the number of MWA carriers (up to eight carriers in Metro & Category-A Service Areas, and up to six carriers in Category-B and Category-C Service Areas) which may be allotted to an access service provider in an LSA. The objective of prescribing a ceiling on the number of MWA carriers could be to ensure an equitable distribution of MWA carriers to various access service providers, and to prevent large holdings of carriers by one or a few access service providers, which may, otherwise, create a scarcity of carriers for other telecom service providers.

2.20 With respect to the ceiling on the number of MWA carriers, TRAI, through the Recommendation dated 29.08.2014, had recommended, *inter-alia*, as 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*

Quantum of Access Spectrum that a Licensee has in a LSA	*Metro/ Cat 'A' Circles*	*Cat 'B' Circles*	*Cat 'C' Circles*
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*

"

2.21 As may be seen from the above table, TRAI had recommended the ceiling on the number of MWA carriers that could be assigned to an access service provider on the basis of the following aspects:

(a) LSA category (viz. Metro, Service Area, Category-A, Category-B and Category-C); and

(b) The quantum of access spectrum held by the access service provider in the LSA.

2.22 These aspects could be referred to as the 'criteria for the ceiling on the number of MWA carriers that may be assigned to an access service provider' recommended by TRAI through the Recommendations dated 29.08.2014. In case it is decided to prescribe a ceiling on the number of carriers that may be assigned to a commercial telecommunication service provider, *prima facie,* there could also be a need for devising a criterion for the ceiling on the number of carriers.

2.23 Through the recommendations dated 29.08.2014, TRAI had also recommended that *"[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."*

2.24 In this context, the Authority took note of the following aspects:

(a) Traditional microwave backhaul bands are spread across a wide range of frequency - from 5.925 GHz to 23.6 GHz. Due to the laws of Physics, the attenuation of signals increases as frequency increases[49]. This means that radio signals lose their strength more rapidly over distance as the frequency goes up. The higher frequencies also experience more absorption and scattering in the atmosphere and through materials. These features make lower microwave backhaul bands more useful than the higher ones from the standpoint of 'propagation distance'.

(b) From the standpoint of 'antenna size', higher microwave backhaul bands score better than lower ones – the higher the frequency, lower the antenna size.

(c) The attractiveness of certain frequency bands for microwave backhaul purposes could be affected due to the presence of other co-primary services in them.[50] The presence of other co-primary services in a frequency band might require careful 'path-planning' for establishing radio backhaul links; it might also put limits on the radiated power on such links.

2.25 In view of the aspects mentioned above, *prima facie*, there could be a need to have separate spectrum caps (ceilings) for different frequency bands, or groups of frequency bands to afford an opportunity to eligible TSPs to acquire the required quantum of spectrum in their desired frequency bands.

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[49] When radio signals travel through air or a vacuum, they get weaker the farther they go. This phenomenon is called free-space path loss (FSPL). FSPL describes the attenuation of signal strength that occurs when an electromagnetic wave travels through open air or a vacuum.
Source: https://resources.pcb.cadence.com/blog/2024-free-space-path-loss

FSPL is given by the following formula:
FSPL (dB) = $20 \log_{10} (d_{km}) + 20 \log_{10} (f_{GHz}) + 92.45$
Where d_{km} is distance in km.
f_{GHz} is frequency in GHz.

[50] For instance, parts of the 18 GHz band viz. 17.7-18.6 GHz and 18.8-19.7 GHz are also being used for Fixed Satellite Service (space-to-Earth), which a primary service in the band. Similarly, 6 GHz (lower) band is also being used for Fixed Satellite Service (Earth-to-space), which a primary service in the band.

(4) Assignment of Spectrum Above the Ceiling Limit

2.26 As mentioned in the previous sub-section, through the Recommendations dated 29.08.2014, TRAI had recommended that *"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…"* [51] Further, TRAI had also recommended that if any TSP requires carriers above the ceiling limit, it may be examined by DoT on a case-to-case basis.

2.27 In case it is decided to permit the assignment of spectrum above the ceiling limit to telecom service providers in certain cases, there could be a requirement of prescribing specific criterion based on which additional spectrum above the ceiling limit may be assigned to a telecom service provider.

(5) Validity Period of Assignment of Spectrum

2.28 As per the extant practice, the spectrum in MWA and MWB bands is assigned to access service providers for a period up to the expiry of telecom service license or expiry of access spectrum assignment, whichever is earlier. In case of (a) TSPs other than access service providers and (b) other entities (non-TSP/ non-commercial isolated/ captive users), the microwave spectrum is generally assigned on an annual basis; upon expiry, the spectrum may be renewed.

2.29 In the report[52] on 'Wireless Backhaul Evolution' (2021), GSMA and ABI Research have presented the findings of a survey on the license duration for the microwave spectrum in 40 countries. The following figure depicts the

[51] TRAI had recommended the ceiling on the number of MWA carriers which could be assigned to a TSP in an LSA on the basis of the quantum of spectrum held by it in the LSA.

[52] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

license durations adopted by the countries surveyed by GSMA and ABI Research in the year 2020:

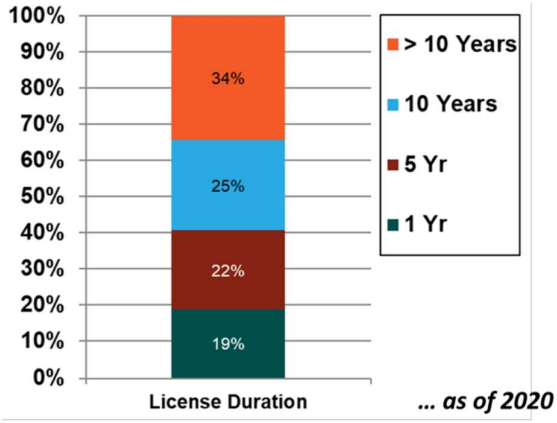


Figure 2.2: Summary of License Durations in the Surveyed Countries[53]

2.30 The afore-mentioned report of GSMA and ABI Research presents the following analysis on the license duration:

"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 and to ensure consistent revenue generation for regulators. However, 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 to innovation.

In contrast, license durations that last for 1 year, accounting for 19% of licenses surveyed, is the least preferred license duration among the countries surveyed. The shorter duration does not protect revenue generation (from the regulators' perspective) and does not ensure technological continuity (from the perspective of the licensee). Conversely, having short, yearly license

[53] ibid

durations gives operators more adaptability in evolving spectrum developments. 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."

2.31 In this background, a question arises as to what should be the validity period of assignment of spectrum in traditional microwave bands for various commercial telecommunication services.

(6) Roll out Obligations

2.32 At present, there are specific roll out obligations in respect of various frequency bands of access spectrum[54] such as 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3.3 GHz, 26 GHz bands. However, the Government has not specified any roll out obligations in respect of the backhaul spectrum. One may argue that there is a need to prescribe suitable roll out obligations for the backhaul spectrum as well to ensure that the backhaul spectrum assigned to access service providers etc. is put to use in a timely and efficient manner. Another view could be that there is no such need as this spectrum would mainly be used for backhauling the telecommunication traffic from access networks, and access service providers are already obliged to fulfil roll out obligations in respect of the access spectrum. However, one may contend that such roll-out obligations are with respect to access spectrum, which varies across spectrum bands; moreover, backhaul spectrum is also assigned to telecom service providers other than access service providers.

[54] Since the year 2010, access spectrum is being assigned through auction in India.

(7) Surrender of the Spectrum

2.33 Through the letter No. L-14042/01/2022-IMT dated 10.11.2022, DoT issued 'Guidelines for Surrender of administratively assigned spectrum for Telecom Service Providers (TSPs) with Access Service Authorisation". The relevant extracts from these guidelines are given below:

"1. Applicant shall submit the request for surrender of administratively assigned frequency carriers (GSM/ CDMA/ MW Access and MW Backbone) to DoT, not before 60 days prior and not later than 30 days prior, to the proposed date of surrender …

2. Applicant shall submit a certified proof of payment from the office of Pr. CCA/ CCA of concerned LSA (where surrender is proposed) regarding payment of Spectrum Charges/ Spectrum Usage Charges (SUC) upto the previous quarter of date of application either on provisional/ final assessment basis or self assessment basis as the case may be. Charges which are sub-judice may be excluded w.r.t proof of payment. An undertaking as per Annexure-I should also be enclosed with the application.

…

4. WPC Wing shall issue the necessary letter to the applicant regarding taking surrender on record within 30 calendar days from receipt of application …"

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

Issues for Consultation:

Q5. What should be the terms and conditions for the assignment of spectrum in traditional microwave backhaul bands for radio backhaul purposes of various commercial telecommunication services, such as -

(a) Carrier size;

(b) Carrier aggregation;

(c) Validity period of the assignment;

(d) Renewal mechanism;

(e) Roll-out obligations; and

(f) Surrender of spectrum, etc.?

Kindly provide a detailed response with justifications along with the international scenario on the matter.

Q6. Is there a need to prescribe ceilings on the number of carriers that can be assigned to a commercial telecommunication service provider in each frequency band [6 GHz (lower)/ 7 GHz/ 13 GHz/ 15 GHz/ 18 GHz/ 21 GHz] or in a group of frequency bands for radio backhaul purposes? Kindly provide a detailed response with justifications.

Q7. In case it is decided to prescribe ceilings on the number of carriers that can be assigned to a commercial telecommunication service provider (TSP) for each frequency band or each group of frequency bands, -

(a) Should there be any criterion for the ceiling on the number of carriers that may be assigned to a TSP? If yes, what should be the criteria?

(b) In case of group of frequency bands, how should the bands be grouped?

(c) What should be the respective ceilings for each frequency band, or each group of frequency band(s)?

(d) Should there be any provision for assignment of spectrum above the ceiling limit on a case-by-case basis? If yes, what criterion should be prescribed, based on which,

additional spectrum above the ceiling limit may be assigned to a telecom service provider?

Kindly provide a detailed response with justifications.

2.35 As per the industry estimates, there are about 500 thousand (five lakh) wireless backhaul links in the country, which have been deployed by using the spectrum in traditional microwave backhaul bands. When an access service provider obtains the right to use a carrier in a particular MWA band in a licensed service area, it deploys that carrier for building a large number of radio backhaul links across the licensed service area. In the network of a typical access service provider, there could be thousands of microwave backhaul links operating on a particular carrier of a traditional microwave backhaul band in a licensed service area.

2.36 As mentioned earlier in this chapter, at present, the assignment of spectrum in traditional microwave bands to access service providers is governed by the DoT's guidelines dated 16.10.2015 read with the addendum dated 25.07.2022 to the guidelines. Notably under the DoT's guidelines dated 16.10.2015, carriers in MWA and MWB bands are assigned 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."

2.37 It is understood that based on the recommendations of TRAI emanating from this consultation process, the Government would frame fresh rules under the Telecommunications Act, 2023 for the assignment of the spectrum in traditional microwave backhaul bands (i.e., MWA and MWB bands) to various types of telecommunication services including access services. In this regard, the Authority took note of the following aspects with respect to the assignment

of spectrum to wireless access service providers in traditional microwave backhaul bands:

(a) Wireless access service providers in the country have made a massive deployment of radio backhaul links in the country using MWA and MWB carriers. Generally, the radio equipment, which have been deployed by wireless access service providers for establishing backhaul links using the spectrum in traditional microwave backhaul bands, are "sub-band" specific. In other words, a typical backhaul radio equipment supports only a sub-band of a particular MWA/ MWB band. For example, in the 15 GHz band, various original equipment manufacturers (OEMs) have developed separate radio equipment in two to four sub-bands. For illustration, in the 15 GHz band, one of the OEMs has developed separate radio equipment in two sub-bands, viz. sub-band 'A' (the first half of the 15 GHz band) and sub-band 'B' (the second half of the 15 GHz band). Radio equipment developed to operate in sub-band 'A' of the 15 GHz band would not support the sub-band 'B' of the 15 GHz band, nor a sub-band of any other MWA/ MWB band.

(b) If for some reason, a carrier of a particular sub-band of an MWA band, held by an access service provider in a licensed service area, is taken away, and a new carrier is assigned to it in some other sub-band of that MWA band or any other MWA band, it would require the access service provider to replace the radio equipment deployed in each of its backhaul link on which the previous carrier was used in the licensed service area. The replacement of the radio equipment on the scale of a license service area would not only have significant cost implications for the access service provider but also may result in a temporary disruption of services, or deterioration of quality of service to the users of the access service provider during the process of replacement of the radio equipment. Apparently, such a situation should be avoided to the extent possible, in the interest of both service providers and users.

2.38 Considering the above, *prima facie*, it appears desirable that while assigning carriers in traditional microwave backhaul bands to telecom service providers under the new policy (to be framed), the telecom service providers holding carriers in traditional microwave backhaul bands should be given a choice to retain carriers held by them.

2.39 In this background, the Authority solicits comments from stakeholders on the following question:

Issue for Consultation:

Q8. In the new policy regime for the assignment of spectrum, whether there is a need to grant an option to telecom service providers already holding carriers in traditional microwave backhaul bands to retain the existing carriers with them? Kindly provide a detailed response with justifications.

B. Need for a Review of the Usage of 7 GHz and 15 GHz Microwave Backhaul Bands

2.40 Through the Reference dated 13.09.2024, DoT has mentioned that *the spectrum band 7.125 to 8.400 GHz (7 GHz) & 14.8-15.35 GHz (15 GHz) are being considered for IMT i.e., Access, under agenda items 1.7 of WRC-2027.* DoT has requested TRAI to provide recommendations on *any need for review in respect of use of 7/ 15 GHz bands in view of consideration of these bands for Access using IMT after WRC-27*.

2.41 The Resolution 256[55] of WRC-23 on "Sharing and compatibility studies and development of technical conditions for the use of International Mobile

[55]Source: https://www.itu.int/dms_pub/itu-r/oth/0c/0a/R0C0A0000100007PDFE.pdf

Telecommunications (IMT)[56] in the frequency bands 4400-4800 MHz, 7125-8400 MHz (or parts thereof), and 14.8-15.35 GHz for the terrestrial component of IMT", *inter-alia*, resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference –

"1. the appropriate studies of technical, operational and regulatory issues pertaining to the possible use of the terrestrial component of IMT in the frequency bands listed in 2, taking into account:

- *evolving needs to meet emerging demand for IMT;*
- *technical and operational characteristics of terrestrial IMT systems that would operate in these specific frequency bands, including the evolution of IMT through advances in technology and spectrally efficient techniques;*
- *the deployment scenarios envisaged for IMT systems and the related requirements of balanced coverage and capacity;*
- *the needs of developing countries; and*
- *the time-frame in which spectrum would be needed;*

2. sharing and compatibility studies, with a view to ensuring the protection of services to which the frequency band is allocated on a primary basis, including protection of stations operating in international waters or airspace which cannot be registered in the MIFR, without imposing additional regulatory or technical constraints on those services, and also on services in adjacent bands, for the frequency bands:

- *4400 - 4800 MHz;*
- *7125 - 8400 MHz; and*
- *14.8 - 15.35 GHz,*

invites administrations to participate actively in the studies and provide the information required for the studies listed under resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference by submitting contributions to ITU-R,

[56] The term "international mobile telecommunication (IMT)" encompasses IMT-2000, IMT-Advanced and IMT-2020 collectively based on Resolution ITU-R 56.
Source: https://www.itu.int/dms_pub/itu-r/opb/hdb/R-HDB-62-2022-PDF-E.pdf

invites the 2027 world radiocommunication conference to consider, based on results of studies, the identification of frequency band(s):

– 4 400-4 800 MHz, or parts thereof, in Region 1 and Region 3;

– 7 125-8 400 MHz, or parts thereof, in Region 2 and Region 3;

– 7 125-7 250 MHz and 7 750-8 400 MHz, or parts thereof, in Region 1;

– 14.8-15.35 GHz,

for the terrestrial component of IMT."

2.42 With respect to Resolution 256 of WRC-23, an agenda item viz. Agenda Item 1.7 (AI 1.7) of WRC-27 has been created. AI 1.7 of WRC-27 is *to consider studies on sharing and compatibility and develop technical conditions for the use of International Mobile Telecommunications (IMT) in the frequency bands 4400 – 4800 MHz, 7125 – 8400 MHz (or parts thereof), and 14.8 – 15.35 GHz taking into account existing primary services operating in these, and adjacent, frequency bands, in accordance with Resolution 256 (WRC-23).*

2.43 The relevant extract of National Frequency Allocation Plan (NFAP) 2022[57], with respect to the allocation of frequency ranges of 7 GHz band and 15 GHz band, is given in the following tables:

Table 2.4: Allocation of the 7 GHz band in NFAP-2022

Frequency Range	Services
7075-7145	FIXED MOBILE
7145-7190	FIXED MOBILE SPACE RESEARCH (deep space) (Earth-to-space)
7190-7235	EARTH EXPLORATION-SATELLITE (Earth-to-space) FIXED

[57] Source: https://dot.gov.in/sites/default/files/NFAP%202022%20Document%20for%20e-release.pdf

Frequency Range	Services
	MOBILE SPACE RESEARCH (Earth-to-space)
7235-7250	EARTH EXPLORATION-SATELLITE (Earth-to-space) FIXED MOBILE
7250-7300	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE
7300-7375	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile
7375-7450	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile MARITIME MOBILE-SATELLITE (space-to-Earth)
7450-7550	FIXED FIXED-SATELLITE (space-to-Earth) METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile MARITIME MOBILE-SATELLITE (space-to-Earth)
7450-7550	FIXED FIXED-SATELLITE (space-to-Earth) METEOROLOGICAL-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile MARITIME MOBILE-SATELLITE (space-to-Earth)
7550-7750	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE except aeronautical mobile MARITIME MOBILE-SATELLITE (space-to-Earth)

Table 2.5: Allocation of the 15 GHz band in NFAP-2022

Frequency Range	Services
14.5-14.8	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE Space research
14.8-15.35	FIXED MOBILE Space research 5.339
15.35-15.4	EARTH EXPLORATION-SATELLITE (passive) RADIO ASTRONOMY SPACE RESEARCH (passive)
15.4-15.43	RADIOLOCATION AERONAUTICAL RADIONAVIGATION
15.43-15.63	FIXED-SATELLITE (Earth-to-space) RADIOLOCATION AERONAUTICAL RADIONAVIGATION

2.44 In India, frequency range 7125-7725 MHz (under the 7 GHz band) and frequency range 14.5-15.5 GHz (under the 15 GHz band) are being used for the microwave backhaul, at present. Under AI 1.7, the entire range of 7125-7725 MHz in the 7 GHz microwave backhaul band is under study for the use of International Mobile Telecommunications (IMT), while out of the 14.5-15.5 GHz range in the 15 GHz microwave backhaul band, the frequency range 14.8-15.35 GHz is under study for the use of IMT. The following figure depicts the frequency ranges for the microwave backhaul vis-à-vis frequency ranges being considered for IMT in WRC- 2027 in 7 GHz and 15 GHz bands.

Figure 2.3: Frequency ranges in the 7 GHz band

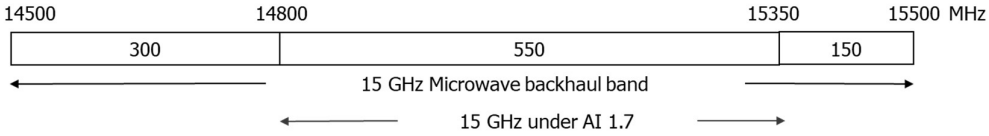


Figure 2.4: Frequency ranges in the 15 GHz band

2.45 The list of present carriers in the 15 GHz microwave backhaul band, as provided by DoT, is given below:

Table 2.6: Carriers in the 15 GHz band

Channel	Uplink frequency (GHz)	Downlink frequency (GHz)
F1/ F1′	14515	14935
F2/ F2′	14543	14963
F3/ F3′	14571	14991
F4/ F4′	14599	15091
F5/ F5′	14627	15047
F6/ F6′	14655	15075
F7/ F7′	14683	15103
F8/ F8′	14711	15131
F9/ F9′	14739	15159
F10/ F10′	14767	15187
F11/ F11′	14795	15215
F12/ F12′	14823	15243
F13/ F13′	14851	15271
F14/ F14′	14879	15299
F15/ F15′	14907	15327

2.46 As listed in the above table, all carriers in the 15 MHz microwave band will have either the uplink or the downlink falling in the 14.8-15.35 GHz range, which is under study for the use of IMT in the AI 1.7 of WRC-27. In case

eventually it is decided to adopt 14.8-15.35 GHz range or IMT, there would no longer be any carriers available for microwave backhaul purposes in the 15 GHz microwave band.

2.47 As mentioned earlier in this chapter, in the 7 GHz microwave backhaul band (7125 -7725 MHz range), there are a total of 10 carriers of 28 MHz (paired). As per the extant practice, carriers in the 7 GHz band are assigned to TSPs and non-TSP isolated captive users on a point-to-point link basis. From the information provided by DoT through its letter dated 08.05.2025, it may be inferred that the 7125-7425 MHz range (the first half of the 7 GHz band) is largely unutilized, while the 7425-7725 MHz frequency range (the second half of the 7 GHz band) is being used scantily.

2.48 In the 15 GHz microwave backhaul band (14.5-15.5 GHz range), there are a total of 15 carriers of 28 MHz (paired). As per the extant practice, carriers in the 15 GHz band are assigned to access service providers on a block-basis in LSA; the access service providers can use the assigned carriers for establishing any number of point-to-point backhaul links within the LSA. For TSPs other than access service providers, and other entities, i.e., non-TSP isolated captive users, the carriers are assigned on a point-to-point link basis. From the information provided by DoT, it may be inferred that the 15 GHz band is the most widely used microwave backhaul band with carrier assignments varying between 7 to 15 carriers per LSA.

2.49 The foregoing discussion may be summarized as below:

(a) Under the AI 1.7 of WRC-27, ITU is considering studies on sharing and compatibility of IMT with existing primary services operating in the frequency ranges 7125-8400 MHz, and 14.8-15.35 GHz.

(b) At present, the frequency ranges 7125-7725 MHz (the 7 GHz band) and 14.5-15.5 GHz (the 15 GHz band) are being used for the microwave backhaul (Fixed Service) in India. The 15 GHz band is a widely used band

for microwave backhauling. In comparison, the 7 GHz microwave band is rather a less utilized band.

2.50 One may argue that in case the frequency ranges 7125-8400 MHz, and 14.8-15.35 GHz are identified for IMT based on the outcome of AI 1.7 of WRC-27, it may affect the usage of the frequency range 7125-7725 MHz (the 7 GHz microwave backhaul band) and the frequency range 14.5-15.5 GHz (the 15 GHz microwave backhaul band), and therefore, the policy for the assignment of the spectrum in these microwave backhaul bands should, at this stage itself, take into account possible outcomes of AI 1.7 of WRC-27. A counter-argument could be that any review of the policy for the assignment of the spectrum in these microwaves backhaul bands would be premature until a final decision is taken in India with respect to the identification of the frequency ranges 7125-8400 MHz, and 14.8-15.35 GHz for IMT based on the outcome of AI 1.7 of WRC-27.

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

Issues for Consultation:

Q9. As the 7125-8400 MHz range in the 7 GHz band and the 14.8-15.35 GHz range in the 15 GHz band are being considered for IMT in WRC-27, whether there is a need to review the usage of 7 GHz and 15 GHz microwave backhaul bands at this stage itself, or should the review be undertaken after considering the outcome of WRC-27? Kindly provide a detailed response with justifications.

Q10. In case it is decided to review the usage of 7 GHz and 15 GHz bands at this stage itself, what should be the policy framework for the assignment of the spectrum in 7 GHz and 15 GHz

microwave backhaul bands to take care the possible outcomes of AI 1.7 of the WRC-27? Kindly provide a detailed response with justifications.

C. Usage of the Traditional Microwave Backhaul Bands for the Last-mile Connectivity

2.52 Universal and Meaningful Connectivity (UMC), as defined by ITU, is the ability for everyone to access the internet in a safe, satisfying, enriching, and productive way, while also being affordable. As per a report from GSMA (2023), 400 million people live beyond the reach of mobile broadband networks, while 3 billion people, despite having network coverage, do not use mobile Internet. In India, at present, the tele-density is about 85% while the broadband internet density is about 67%. Meaning thereby, a significant population in the country is yet to reap the benefits of telephony and broadband internet (digital access). ITU emphasizes that UMC is crucial for enabling digital transformation and achieving the Sustainable Development Goals. A multi-stakeholder working group led by ITU and UNICEF has set aspirational targets for UMC under the following three heads:

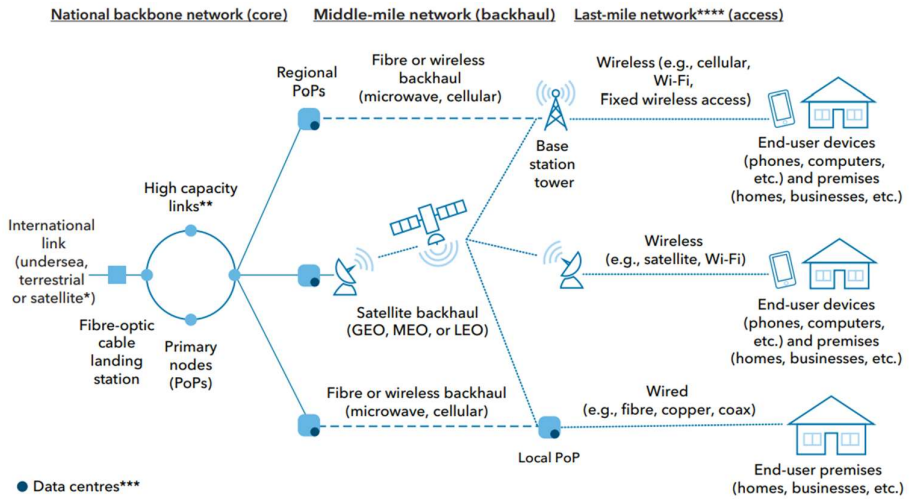
(a) Universality targets are meant to ensure that 100% of the population above 15 years, households, businesses and schools have access to the internet.

(b) Technology targets are meant to ensure higher speeds for fixed broadband.

(c) Affordability targets are meant to ensure low entry-level broadband costs as a percentage of the income of the lower income population of the country.

2.53 ITU notes that while there are many barriers to access, getting network infrastructure in place to support broadband services remains a huge

challenge for nations – both developing and developed – where vast geographical distances, rugged or inhospitable terrain, or widely dispersed island communities are a factor[58]. In respect of the last-mile connectivity, ITU has published "The Last-mile Internet Connectivity Solutions Guide: Sustainable connectivity options for unconnected sites" (2020)[59] (hereinafter, also referred to as "the ITU's guide"). The ITU's guide aims to drive new strategies to extend connectivity to those at the bottom of the social pyramid. The ITU's guide has depicted the telecommunication network components supporting last-mile interventions in developing countries through the following figure.



**** The technologies listed for the last mile are not exhaustive.

Figure 2.5: Telecommunication network components supporting last-mile interventions in developing countries, Source: ITU

2.54 In essence, the ITU's guide recognizes numerous infrastructure technologies for connecting the last mile network[60] in developing countries viz.

(a) Wireless technologies (cellular: 2G, 3G, 4G, 5G, fixed wireless access, Wi-Fi, satellite, etc.), and

[58] Source: https://www.itu.int/dms_pub/itu-d/opb/tnd/D-TND-01-2020-PDF-E.pdf

[59] ibid

[60] As per the ITU's guide, the "last-mile network" is where the Internet reaches the end users and includes the local access network, including the local loop, the central office, exchanges and wireless masts.

(b) Wired technologies (fibre, copper, coax, etc.).

2.55 It is worth noting that as far as wireless-based last mile connectivity options are concerned, 2G, 3G, 4G and 5G mobile networks are extensively used in India. However, fixed wireless access, satellite technologies etc. are yet to be fully tapped.

2.56 Through the Reference dated 13.09.2024, DoT has informed that *"one of commercial telecom service providers holding Unified License with Access service authorisation and providing wireline services has requested for spectrum in the 6/ 7/ 13 GHz bands for establishing links for last mile connectivity solutions in certain Licensed Service Areas".* In this regard, DoT has requested TRAI to provide recommendations on *quantum/ band(s) of spectrum to be earmarked for last mile connectivity (Fixed Wireless Access) of commercial telecom services and methodology of assignment of spectrum and associated terms & conditions in non-IMT bands*.

2.57 With respect to the last mile connectivity through the fixed wireless access, the ITU's guide states that "*Fixed wireless access uses licensed radio frequencies allocated to fixed services or unlicensed bands (e.g. Wi-Fi) to provide connectivity. … it can also use mobile service bands*..."

2.58 In India, at present, the last-mile connectivity through fixed wireless access (FWA) is not being provided by using the microwave backhaul spectrum (radio frequencies allocated to Fixed Service). However, with the introduction of 5G mobile networks in 2022, access service providers have started providing fixed wireless access using IMT-bands[61] such as the 3.3 GHz band, and delicensed bands such as the 5 GHz band. At present, FWA services are at an early stage

[61] The frequency bands identified for IMT are often referred to as "IMT bands". In India, The National Frequency Allocation Plan (NFAP)-2022 has provided the list of IMT-bands under the footnote "IND 16". As per IND 16, several frequency bands have been identified for the implementation of IMT.
Source: https://dot.gov.in/sites/default/files/NFAP%202022%20Document%20for%20e-release.pdf

of growth in India. In the past couple of years, about 6.7 million FWA connections have been provided to users in the country.[62]

2.59 As mentioned in Chapter I of this consultation paper, the Telecommunications Act, 2023 provides an explanation under entry 12 (radio backhaul for telecommunication services) of Schedule I as below:

"Explanation.- The term "radio backhaul" shall mean the use of radio frequency only to interconnect telecommunication equipment, other than the customer equipment in telecommunication networks."

2.60 In the scheme of the Telecommunications Act, 2023, the usage of spectrum to connect telecommunication equipment (other than customer equipment) in telecommunication networks is 'radio backhaul for telecommunication services'. Conversely, if spectrum is used to connect a customer equipment in telecommunication networks, it shall not be covered under the definition of 'radio backhaul for telecommunication services'. The last mile connectivity (fixed wireless access) to the customer equipment in telecommunication networks is, essentially, the "access" part of telecommunications.

2.61 Section 4(4) read with the First Schedule of the Telecommunications Act, 2023 provides that the assignment of spectrum for radio backhaul purposes shall be through an administrative process. Further, Section 4(4) of the Telecommunications Act, 2023 provides that *the Central Government shall assign spectrum for telecommunication through auction except for entries listed in the First Schedule*. Therefore, the assignment of the spectrum for the last mile connectivity (fixed wireless access) to the customer equipment in telecommunication networks will be made through auction in terms of Section 4(4) of the Telecommunications Act, 2023.

[62] As on 31.03.2025, there were 6,769,089 number of 5G fixed wireless access (FWA) subscribers in the country. Source: TRAI's press release on Telecom Subscription Data as on 31st March, 2025, accessible at the following URL: https://trai.gov.in/sites/default/files/2025-05/PR_No.35of2025.pdf

2.62 *Prima facie,* apart from access service providers, there could be other types of telecom service providers - such as internet service providers and M2M service providers - which might require the spectrum in traditional microwave backhaul bands for providing the last mile connectivity (fixed wireless access) to the customer equipment in telecommunication networks i.e., for "access" purposes.

2.63 Regarding the use of the spectrum in traditional microwave backhaul bands for the last-mile connectivity (fixed wireless access) to the customer equipment in telecommunication networks, one may contend that the access spectrum available in various IMT-bands (including 3300 MHz, 26 GHz and 37 GHz bands) can be used for providing the last-mile connectivity (fixed wireless access) to the customer equipment instead of using the spectrum in microwave backhaul bands (non-IMT bands).

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

Issues for Consultation:

Q11. Whether there is a need to earmark certain quantum of spectrum in traditional microwave backhaul bands for the last-mile connectivity (Fixed Wireless Access) to the customer equipment of commercial telecommunication services? Please provide a detailed response with justifications.

Q12. In case it is decided to earmark certain quantum of spectrum in traditional microwave backhaul bands for the last-mile connectivity (Fixed Wireless Access) to the customer equipment of commercial telecommunication services, -

(a) What quantum of spectrum, and in which of 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands should be earmarked for such purposes?

(b) What should be the eligibility conditions to obtain the spectrum in traditional microwave backhaul bands for such purposes?

(c) What should be the terms and conditions for the assignment of spectrum in traditional microwave backhaul bands for such purposes through auction such as-

(i) Block size;

(ii) Minimum quantity for bidding;

(iii) Spectrum cap;

(iv) Validity period of the assignment;

(v) Roll-out obligations;

(vi) Surrender of spectrum etc.?

(d) Whether flexible use i.e., both backhaul connectivity, and last mile connectivity (fixed wireless access) to the customer equipment should be permitted in the frequency ranges earmarked for such purposes? If yes, should the terms and conditions of the auction of spectrum be the same as those applicable for the "access spectrum"?

Kindly provide a detailed response with justification and international practice.

D. Non-commercial/ Captive Usage of the Spectrum in Traditional Microwave Backhaul Bands for Radio Backhaul Purposes

2.65 Through the Reference dated 13.09.2024, DoT has informed that *"point to point connectivity requirements of certain captive users is required to be met from one or more of these bands i.e. 6/ 7/ 13/ 15/ 18/ 21 GHz bands. Such*

requirements are generally localised and mostly limited to few links only. In case, some carriers are specifically earmarked for such use, they can be re-used among multiple users with geographical separation". In this regard, DoT has requested TRAI to provide recommendations on "*quantum/ band(s) of spectrum to be earmarked for backhaul purposes for non-commercial/ captive use and associated terms & conditions including charges*".

2.66 As mentioned earlier in this chapter, at present, DoT assigns microwave spectrum for backhaul purposes in traditional microwave backhaul bands to not only telecom service providers but also non-TSP entities for their non-commercial/ captive usages. Such assignments are given point-to-point link-wise on an annual basis, which may be renewed upon request from the concerned entities. As per the information provided by DoT on 08.05.2025, many entities including government organizations and public sector units (PSUs) have obtained carriers in the traditional microwave backhaul bands from DoT for their captive usages. However, at present, the extent of usage is rather low. Spectrum charges for such microwave links are governed by the DoT's order dated 11.12.2023[63] on the spectrum charges for the assignment of frequencies to captive users for different types of radiocommunication services and applications.

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

Issues for Consultation:

Q13. Should a certain quantum of the spectrum in traditional microwave backhaul bands be earmarked for fulfilling point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users? If yes -

[63] https://dot.gov.in/sites/default/files/Spectrum%20usage%20charges.pdf

(a) What quantum of spectrum, and in which of 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands should be earmarked for such purposes?

(b) What should be the terms and conditions for the assignment of spectrum for such purposes, such as-

(i) Carrier size;

(ii) Carrier aggregation;

(iii) Ceiling on the number of carriers;

(iv) Validity period of the assignment;

(v) Renewal mechanism;

(vi) Criteria for the assignment of additional spectrum above the ceiling limit;

(vii) Roll out obligations; and

(viii) Surrender of the spectrum, etc.?

Kindly provide a detailed response with justifications.

Q14. In case your response to Q13 is 'no', in what manner should the point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users be fulfilled? Kindly provide a detailed response with justifications.

E. Minimum Link Length of Point-to-Point Links

2.68 As mentioned earlier in this chapter, at present, MWA carriers are assigned to access service providers on a block-basis in LSA. On the other hand, MWB carriers are assigned to access service providers on a point-to-point link basis. Further, MWA and MWB carriers to (a) TSPs other than access service providers, and (b) other entities i.e., non-TSP isolated captive users are assigned only on a point-to-point link basis.

2.69 As per the Order dated 23.03.2005 issued by Wireless Planning & Coordination (WPC) Wing of DoT, MWB carriers are assigned for a minimum link length of

15 km in plain regions. In the hilly terrains (includes Assam, North East, Himachal Pradesh and Jammu & Kasmir LSAs), MWB carriers are assigned for a minimum link length of 10 km. Notably, there is no restriction on the link length for MWA carriers.

2.70 The Authority notes that the Infocomm Media Development Authority (IMDA), Singapore has prescribed a minimum path length for each traditional microwave backhaul band. IMDA, Singapore, in its Spectrum Management Handbook (June 2022)[64] has mentioned *inter-alia* that "…*As such IMDA generally assigns frequencies for point-to-point fixed service links on a shared-use basis. Use of exclusive frequency assignment is discouraged. For the request for exclusive frequency assignment, the applicant will be required to provide justifications and only usage that warrant such assignment is approved. … The lower frequency bands are known to have propagation characteristics suitable for longer links. To ensure the efficient use of frequencies in these bands, IMDA will decide the choice of frequency band based on the path length of the fixed service link. As a general rule, the request for a frequency in any band should satisfy the minimum path length as stipulated in Table 1."* The relevant extract of Table 1 of the IMDA's Spectrum Management Handbook is given below:

Table 2.7: Minimum Path Length Prescribed by IMDA, Singapore[65]

Frequency Range	Minimum Path Length
5925 - 6425 MHz	20 km
6425 - 7125 MHz	20 km
7125 - 7725 MHz	20 km
7725 - 8500 MHz	20 km
10.5 - 10.68 GHz	15 km
10.7 - 11.7 GHz	15 km

[64] Source: https://www.imda.gov.sg/-/media/imda/files/regulation-licensing-and-consultations/frameworks-and-policies/spectrum-management-and-coordination/spectrummgmthb.pdf
[65] Source: https://www.imda.gov.sg/-/media/imda/files/regulation-licensing-and-consultations/frameworks-and-policies/spectrum-management-and-coordination/spectrummgmthb.pdf

12.2 - 12.7 GHz	15 km
12.75 - 13.25 GHz	15 km
14.4 - 15.35 GHz	10 km
17.7 - 19.7 GHz	5 km
21.2 - 23.6 GHz	2 km

2.71 In case it is decided to assign the spectrum in traditional microwave backhaul bands on a point-to-point link basis to cater to point-to-point connectivity requirements of commercial telecommunication service providers as well as captive (non-commercial/ Non-TSP) users, *prima facie*, there could be a need to prescribe a minimum link length (path length) in each of the traditional microwave backhaul bands to ensure efficient usage of frequencies in such bands.

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

Issue for Consultation:

Q15. In case it is decided to assign the spectrum in traditional microwave backhaul bands on a point-to-point link basis to cater to point-to-point connectivity requirements of commercial telecommunication service providers as well as captive (non-commercial/ Non-TSP) users, whether there is a need to prescribe minimum link lengths (path lengths) in these bands? If yes, what should be the minimum link length for each of the traditional microwave backhaul bands? Kindly provide a detailed response with justifications.

F. Delicensed Usage of the 6 GHz (Lower) Band

2.73 As mentioned in Chapter I of this consultation paper, DoT, through a letter dated 08.05.2025, has informed that it "*has decided to de-license the lower 6 GHz band (5925-6425 MHz) for low power applications. Relevant rules are under consideration in the Department for notification*." In this regard, DoT, on 16.05.2025, has circulated draft rules for public consultation by the name (draft) "Use of Low Power and Very Low Power Wireless Access System including Radio Local Area Network in Lower 6 GHz band (Exemption from Licensing Requirement) Rules, 2025". The draft rules provide, *inter-alia*, as below:

"4. Exemption. — No Authorization or Frequency Assignment shall be required to establish, maintain, work, possess or deal in any wireless equipment for the purpose of Lower Power Indoor and Very Low Power outdoor wireless access systems, including radio local area networks operating in the frequency band 5925-6425 MHz on noninterference, non-protection and shared (nonexclusive) basis, and complying with the following technical parameters; namely:

Table

Low power indoor and Very Low Power Outdoor WAS/ RLAN Access Points and devices

Device Type	*Max. PSD e.i.r.p for in-band emissions*	*Max. e.i.r.p for in band emissions*	*Max. Emission Bandwidth*	*Out of band emissions (Max e.i.r.p density)*
Low Power Indoor	*5 dBm/MHz*	*30 dBm*	*320 MHz*	*-27 dBm/MHz*
Very Low Power Outdoor	*-5 dBm/MHz*	*14 dBm*	*320 MHz*	*-27 dBm/MHz*

…"

2.74 The Authority notes that as per the National Frequency Allocation Plan (NFAP) 2022, the 6 GHz (lower) band is allocated to three services on a primary basis viz. Fixed Service, Fixed Satellite Service (Earth-to-space), and Mobile Service. As per the information provided by DoT through the letter dated 08.05.2025, spectrum in this band has been assigned not only for radio backhaul purposes (Fixed Service) but also to numerous teleport providers, digital satellite new gathering (DSNG) service providers, headend-in-the-sky (HITS) service providers, and captive Very Small Aperture Terminal (VSAT) service providers in India.

2.75 In this context, the Authority perused the prevalent regulatory regimes in other countries with respect to the delicensed usage of the 6 GHz (lower) band. A brief description of the international practices on the matter is given below:

(1) United States of America (USA)

2.76 In April 2020[66], the Federal Communications Commission (FCC), USA adopted rules to make 1200 MHz (5925-7125 MHz) of spectrum available for unlicensed use in the 6 GHz band.[67] The FCC authorized indoor low-power

[66] Source: https://docs.fcc.gov/public/attachments/fcc-20-51a1.pdf

[67] The power limitations imposed by the FCC for various types of devices are given below:

Device Class	Operating Bands	Maximum EIRP	Maximum EIRP Power Spectral Density
Standard-Power Access Point (AFC Controlled)	U-NII-5 (5.925-6.425 GHz) U-NII-7 (6.525-6.875 GHz)	36 dBm	23 dBm/MHz
Client Connected to Standard-Power Access Point		30 dBm	17 dBm/MHz
Low-Power Access Point (indoor only)	U-NII-5 (5.925-6.425 GHz) U-NII-6 (6.425-6.525 GHz) U-NII-7 (6.525-6.875 GHz) U-NII-8 (6.875-7.125 GHz)	30 dBm	5 dBm/MHz
Client Connected to Low-Power Access Point		24 dBm	-1 dBm/MHz

Source: ibid

operations over the full 1200 MHz and standard-power devices in 850 MHz in the 6 GHz band, as below:

(a) Low Power Devices: The FCC permitted authorized indoor low-power access points across the entire 6 GHz band (5925-7125 MHz). The access points will connect the devices in homes and businesses such as smartphones, tablet devices, laptops, and Internet-of-things (IoT) devices to the Internet.

(b) Standard Power Devices: The FCC permitted authorized automated frequency coordination (AFC)[68] controlled standard-power access points in frequency ranges 5925-6425 MHz and 6525-6875 MHz. The AFC system will prevent standard power access points from operating where they could cause interference to incumbent services. These access points can be deployed anywhere as part of hotspot networks, rural broadband deployments, or network capacity upgrades where needed.

2.77 While permitting the unlicensed usage of the 6 GHz band, the FCC ensured that the unlicensed devices would share spectrum with incumbent licensed services and protect licensed services. The specific conditions prescribed by the FCC for the protection of incumbent users of the frequency band, are given below:

(a) Fixed Microwave Services: The AFC system must establish location and frequency-based exclusion zones around fixed microwave receivers operating in these bands. Individual standard power access points and fixed client devices must not operate co-channel to fixed microwave system frequencies within co-channel exclusion zones, or on adjacent channel frequencies within adjacent channel exclusion zones.

(b) Radio Astronomy Services: The AFC system must enforce an exclusion zone to radio observatories that observe between 6650-6675.2 MHz.

[68] Automated Frequency Coordination (AFC) is a spectrum use coordination system that consists of a registered database of all the bands in use by various types of radio frequency services in a particular area.

(c) Fixed-Satellite Services: Standard power access points and fixed client devices located outdoors must limit their maximum EIRP at any elevation angle above 30 degrees as measured from the horizon to 21 dBm to protect fixed satellite services.

2.78 Subsequently, the FCC permitted Very Low Power (VLP) devices[69] to operate across the entire 6 GHz band. VLP devices have no restriction on locations and are not required to operate under the control of an AFC system.

(2) European Commission

2.79 In June 2021, the European Commission (EC) implemented a decision[70] for delicensing the lower 6 GHz band (5945-6425 MHz) for Low Power Indoor (LPI) and Very Low Power (VLP) wireless access systems (WAS) including radio local area networks (RLAN) on a non-exclusive, non-interference and non-protected basis[71]. While taking this decision, the European Commission noted that the studies carried out by CEPT[72] indicate that the coexistence of delicensed devices with terrestrial fixed service deployments (fixed links) and FSS Earth stations in the 5945-6425 MHz range is feasible, subject to certain conditions to ensure adequate protection of existing usages in and adjacent to the 5945-6425 MHz range from harmful interference originating from WAS/ RLAN equipment.

[69] The power limits for VLP: Up to -5 dBm/MHz EIRP power spectral density (PSD) and 14 dBm EIRP

[70] Decision (EU) 2021/1067 (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021D1067)

[71] The European Commission prescribed the following technical conditions on the delicensed use of the 6 GHz band:

Low power indoor (LPI) WAS/RLANs devices

Parameter	Technical conditions
Permissible operation	Restricted to indoor use, including in trains. Outdoor use, including in road vehicles, is not permitted.
EIRP $_{Max\ mean}$	23 dBm
EIRP $_{Max\ mean}$ density	10 dBm/MHz

Very Low Power (VLP) WAS/RLAN devices

Parameter	Technical conditions
Permissible operation	Indoors and outdoors. Use on Unmanned Aircraft Systems (UAS) is not permitted.
EIRP $_{Max\ mean}$ for in-band emissions	14 dBm

[72] CEPT stands for European Conference of Postal and Telecommunications Administrations.

(3) United Kingdom (UK)

2.80 In July 2020[73], the Ofcom decided to make available the lower 6 GHz band (5925-6425 MHz) for Wi-Fi and other RLAN[74] devices on a licence-exempt basis, enabling indoor and very low power (VLP) outdoor use[75]. The licensed-exempt usage was permitted on a non-protected and non-interference basis with technical parameters that provide adequate protection for other users. With respect to the possibility of a harmful interference to fixed services owing to such delicensing, Ofcom noted that "*Our technical analysis shows that no harmful interference to fixed links is likely to be caused by our decisions. We do not consider that there is a need for further analysis, noting that our analysis took into account fixed links with a variety of topologies and also included critical infrastructure links. Furthermore, in case of harmful interference caused by non-compliant devices, we will consider taking enforcement action where appropriate.*"

(4) Australia

2.81 In March 2022[76], the Australian Communications and Media Authority (ACMA), Australia decided to allow two different classes of device – low power indoor (LPI) and very low power (VLP) devices in the lower 6 GHz band (5925-6425 MHz) with differing operating restrictions[77]. Regarding the coexistence with

[73] Ofcom: Improving spectrum access for Wi-Fi Spectrum use in the 5 GHz and 6 GHz bands [Source: https://www.ofcom.org.uk/spectrum/frequencies/improving-spectrum-access-for-wi-fi]

[74] RLAN is an acronym of 'Radio Local Area Network'. An RLAN, or wireless Local Area Network (WLAN) is a radio access system used to provide wireless access between computer devices. Source: https://en.telecomabc.nl/r/rlan.html

[75] Ofcom decided a maximum EIRP of 250mW for indoor use and a maximum EIRP of 25mW for outdoor use. Aeronautical mobile use is not permitted. Airborne use of the relevant equipment is permitted within an aircraft only to establish a connection with a station or apparatus within the same aircraft.

[76] Proposed updates to the LIPD Class Licence for 6 GHz RLANs - Outcomes paper, March 2022 [Source: https://www.acma.gov.au/sites/default/files/2022-03/Outcomes%20Paper_Proposed%20updates%20to%20the%20LIPD%20Class%20Licence%20for%206%20GHz%20RLANs.pdf]

[77] ACMA prescribed the following power limits and restrictions specific to LPI devices and VLP devices:

Restriction criteria	For LPI devices	VLP devices
Maximum power	24 dBm EIRP	14 dBm EIRP

incumbent fixed services, ACMA in the October 2021[78] consultation paper stated that *"the outcomes of previous studies conducted in jurisdictions where arrangements for RLANs in the 6 GHz band have been made, along with a lack of feedback in submissions to the April 2021 consultation, we are comfortable that the LPI and VLP devices proposed can co-exist with existing and future fixed point-to-links in the band."*

2.82 From the above description of international scenario, it can be inferred that while permitting the de-licensed usage in the 6 GHz band, the national regulators have made provisions to provide necessary protection to the incumbent users, including Fixed Service, Fixed Satellite Service (FSS) etc. As DoT *has decided to de-license the lower 6 GHz band (5925-6425 MHz) for low power applications*, it needs to be examined as to whether there is any requirement for devising specific measures to provide necessary protection to incumbent users such as Fixed Microwave (backhaul) Services, FSS etc. operating in the 6 GHz (lower) band.

2.83 In this background, the Authority solicits inputs of stakeholders on the following questions:

Issues for Consultation:

Q16. Considering that the Government has decided to delicense the 6 GHz (lower) band (5.925-6.425 GHz) for low power applications, whether there is any need to prescribe certain measures to provide necessary protection to incumbent users such as Fixed Microwave (backhaul) Services, Fixed Satellite

Maximum power density	11 dBm/MHz EIRP	1 dBm/MHz EIRP
Operation	Indoor	Any location

[78] Source: ACMA's consultation paper on Proposed updates to the LIPD Class Licence for 6 GHz RLANs, October 2021 Source: https://www.acma.gov.au/sites/default/files/2021-10/Proposed%20changes%20to%20LIPD%20class%20licence%20for%206GHz%20RLAN_consultation%20paper.docx

Service (FSS) etc. operating in the 6 GHz (lower) band? If yes, which specific measures should be prescribed for this purpose? Kindly provide a detailed response with justifications.

Q17. Any other suggestions relevant to the assignment of spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands may kindly be provided with detailed justifications.

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

Chapter III: Issues Related to Assignment of the Spectrum in E-Band and V-Band

3.1 Till the middle of the last decade, the voice telephony was the flagship service for cellular mobile service providers in India. At that time, the data traffic was rather miniscule in comparison to the voice telephony traffic. The wireless data traffic witnessed a remarkable growth in the Financial Year (FY) 2017 onwards with large-scale deployments of fourth generation (4G) cellular mobile networks in the country. The growth in the mobile data traffic in India got a further boost in FY 2023 when the fifth generation (5G) cellular mobile networks were introduced in the country. To put things in perspective, the annual mobile data usage in India in the last 11 years has been plotted in the following figure.

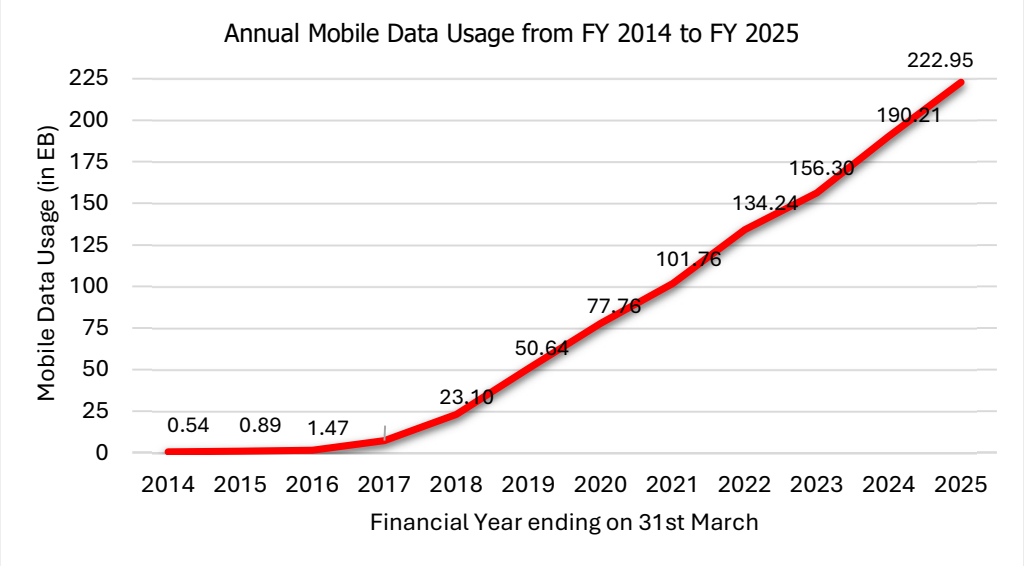


Figure 3.1: Annual Mobile Data Usage in the Past 11 Years

3.2 As may be seen from the figure above, the mobile data traffic has followed a "hocky-stick curve" depicting sudden and extremely rapid growth after a significant period of tepid growth. With the consistent rise in the adoption of

5G, the mobile data traffic in the country is set to grow manifold in the near future.

3.3 Until the introduction of 5G mobile networks in India in 2022, the access spectrum holding of access service providers in India was, generally, of the order of 60 to 80 MHz (in a mix of FDD and TDD bands[79]) in each LSA. With this amount of access spectrum, a cellular mobile base station site could typically deliver a throughput of the order of 200 Mbps with the radio access technologies (2G, 3G and 4G) prevalent at that time. To backhaul the telecommunication traffic of about 200 Mbps, a carrier of 28 MHz (paired) in traditional microwave backhaul bands was generally sufficient. After the introduction of 5G mobile networks in India, the typical throughput of a base station site enabled with the 5G radio equipment increased to the order of 1 Gbps mainly on account of two factors viz. the addition of new 5G spectrum in the mid-band (3300 MHz band), and the usage of massive MIMO (Multiple Input Multiple Output) antennas. To backhaul the telecommunication traffic of about 1 Gbps, a single carrier (or a couple of carriers) in traditional microwave backhaul bands was no longer sufficient. In effect, the introduction of 5G mobile networks in the country necessitated an urgent upgradation of wireless backhaul links. The OFC-based backhaul was technically the preferred choice for TSPs to connect 5G-enabled base station sites. However, as discussed in Chapter I of this consultation paper, OFC-based backhauling solutions are not only costly but installing OFC is also a tedious process which takes significant time and effort. Moreover, there may be some infrastructural challenges for cabling certain areas, such as roads or densely populated urban centers. The impending mass-scale deployment of 5G mobile networks and the concerns relating to cost and time challenges of OFC-based backhauling led TSPs on a pursuit for "high capacity" wireless backhaul systems.

[79] At that time, access service providers held the access spectrum in 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz bands.

3.4 The quest for "high capacity" wireless backhaul systems began much earlier - in the beginning of this century - to cater to the needs for the future-generation mobile networks. World-over, millimeter wave (mmWave) frequencies[80] i.e. the frequencies in the 24-300 GHz range, where a large quantum of bandwidth was lying vacant, were actively explored for building "high capacity" wireless backhaul systems and "high capacity" radio access networks. The initial wireless backhaul systems, which were built on mmWave frequencies, were not fitting the requirement due to their high-power consumption, and hardware characteristics. However, with the passage of time, the initial developmental challenges were overcome, and two high-frequency bands viz. E-band and V-band were identified for building "high capacity" wireless backhaul systems to cater to the needs of 5G mobile networks and beyond.

3.5 In the following sections, the characteristics of the spectrum in E-band and V-band and their potential for the usage in wireless backhaul systems have been briefly outlined. Thereafter, the issues related to the assignment of the spectrum in these bands have been examined.

A. E-band

3.6 E-band frequencies are line-of-sight radio waves in the frequency range of 71-76 GHz paired with 81-86 GHz. The E-band is often referred to as "the 70/ 80 GHz band". E-band antennas are highly directional. As a result, wireless backhaul systems operating in E-band frequencies can transmit highly focused, point-to-point "pencil beam" signals. Frequency coordination, interference mitigation and path planning are much simpler in the E-band as compared to traditional microwave backhaul bands. Besides, the E-band

[80] As per the nomenclature of ITU (Final Acts, WRC-15), the extra high frequency (EHF) band i.e. 30-300 GHz range is referred to as "millimetric waves". However, in general, the term "millimeter waves (mmWaves)" is used in telecommunications to refer to the frequencies from 24 GHz to 300 GHz.

spectrum can support more capacity per backhaul link at a comparatively lower cost.

3.7 As per Ericsson's Microwave Outlook Report 2024[81], the E-band has been on a remarkable journey over the last decade and is now extensively used as a 5G backhaul band. As per the ETSI White Paper[82] on E-Band (2020), the E-band can cover the most popular 5G uses cases, requiring high capacity over relative short hops up to 2 km. As per the report[83] of GSMA and ABI Research on 'Wireless Backhaul Evolution' (2021), the E-band will be important across all regions and is expected to enjoy an exceptional growth of 11.6% CAGR from 2021 to 2027. According to ABI Research[84], E-band links are expected to grow to over 2.5 million in the year 2027 making up 33% of total wireless backhaul links. ABI Research has also made a comparison of the global mobile base station wireless backhaul links in 2022 Vs 2027 (forecast) as below:

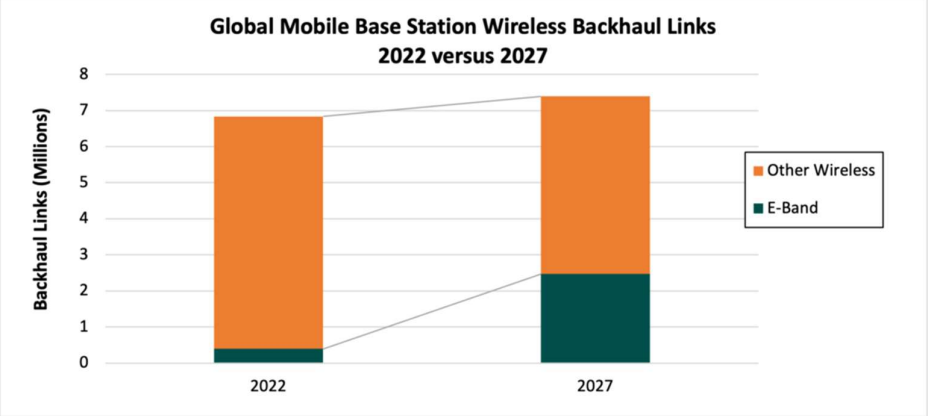


Figure 3.2: Comparison of Wireless Backhaul Links in 2022 Vs 2027[85]

[81] Source: https://www.ericsson.com/4a7bec/assets/local/reports-papers/microwave-outlook/2024/ericsson-microwave-outlook-report-2024.pdf

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

[83] Source: https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

[84] Source: https://www.rcrwireless.com/20230807/5g/the-use-of-e-band-for-backhaul-a-key-ingredient-for-successful-5g-beyond-analyst-angle

[85] ibid

B. V-band

3.8 The V-band is characterized by a continuous block of 9 GHz of spectrum between 57 and 66 GHz[86]. The V-band is often referred to as "the 60 GHz band". A defining characteristic of the V-band is the significant absorption of radio waves by oxygen (O_2) within this frequency range as depicted in the following figure:

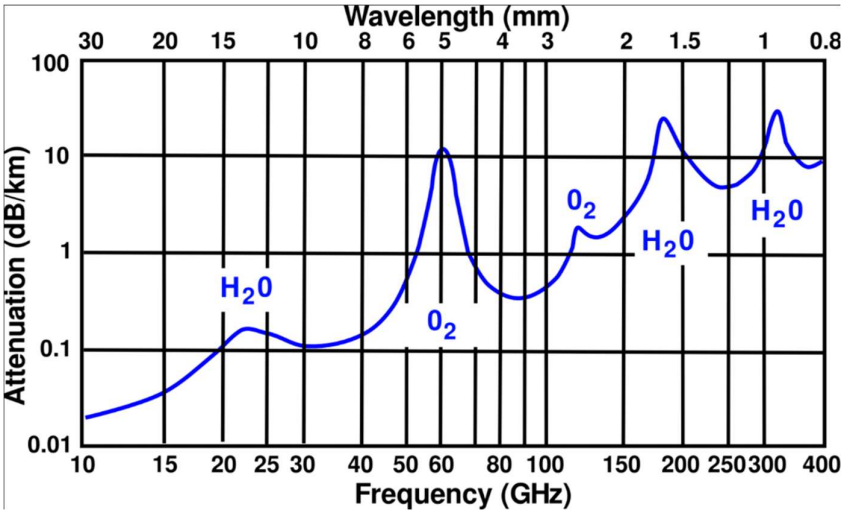


Figure 3.3: Attenuation of signals due to atmospheric absorption[87]

3.9 The oxygen absorption in the V-band is of the order of 15 dB/ km. As a result, radiations in the V-band are quickly reduced. Though it limits the distances that a V-band link can cover, it also makes a V-band link highly immune to interference from other V-band links. V-band antennas are highly directional and together with the propagation limitations, wireless systems operating at the V-band frequencies can transmit highly focused, point-to-point "pencil beam" signals allowing a much higher reuse of the same frequency in a given area. These propagation characteristics together with the fact that a large bandwidth of 9 GHz is available in the band make the spectrum in the V-band

[86] Source: https://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp9_e_band_and_v_band_survey_20150629.pdf

[87] https://www.slideserve.com/ednaa/wigig-technologies-ieee-802-11ad-ay-powerpoint-ppt-presentation

a good candidate for short-hop high-capacity backhauling. The applications could include radio backhaul solutions for small cells.

3.10 Ericsson, in its report on Microwave Outlook (2022), has provided an estimate of the composition of the new backhaul links in terms of frequency ranges from the year 2015 to 2027 (forecast) as below.

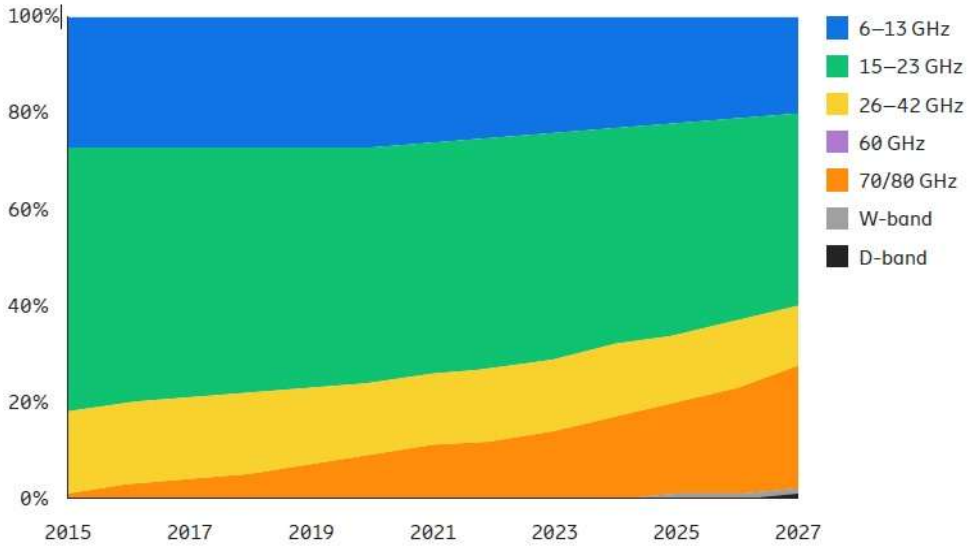


Figure 3.4: New deployment share per frequency range, Source: Ericsson[88]

3.11 As can be seen from the above figure provided by Ericsson, while the E-band is being adopted at a fast pace, the V-band does not seem to show any significant deployment for radio backhaul purposes yet.

C. TRAI's Earlier Recommendations on the Assignment of the Spectrum in E-band and V-band

3.12 As already mentioned in Chapter I of this consultation paper, TRAI, in the year 2014, sent its recommendations on 'Allocation and Pricing of Microwave

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

Access (MWA) and Microwave Backbone (MWB) RF carriers' to DoT. On some of the issues, DoT sought clarification/ reconsideration on TRAI's recommendations through back reference dated 16.10.2015. TRAI provided 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 the response to the back-reference, are reproduced below:

(i) In order to increase broadband penetration in India, the usage of high capacity backhaul E-band (71-76 / 81-86 GHz) and V-band (57-64 MHz) may be explored for allocation to the telecom service providers.

(ii) 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.

(iii) Channel bandwidth for E-band (71-76 GHz and 81-86 GHz) should be 250 MHz with a guard band of 125 MHz at the top and bottom of each 5 GHz band. More than one channel can be allowed and allocated for aggregation.

(iv) Channel bandwidth for V-band (57-64 GHz) should be 50 MHz with a 100 MHz guard band at the beginning of the band. More than one channel can be allowed and allocated for aggregation.

(v) 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.

(vi) V-band carriers should be charged Rs. 1000 (Rs. One Thousand) per annum per carrier of 50 MHz each. More than one channel can be allocated and allowed for aggregation. There should be an initial promotional discount of 50% for three years from the date of allocation of the first carrier in this band.

(vii) 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.

(viii) The prices mentioned for E-band and V-band has to be reviewed after 5 years based on deployment and usage of the links.

(ix) V-band (57-64 GHz) should be delicensed for indoor and outdoor based access applications like Wi-Fi hotspots etc.

3.13 As mentioned in Chapter I of this consultation paper, DoT, through the Reference dated 12.08.2022, informed that it has been decided to seek fresh recommendations of TRAI on the matter.

D. Aspects on Which DoT has Sought Recommendations of TRAI w.r.t. Assignment of Spectrum in E-band and V-band

3.14 Regarding the spectrum in E-band and V-band, DoT, through the Reference dated 13.09.2024, requested TRAI to provide recommendations, *inter-alia*, on the following aspects:

(a) Demand assessment and scope of service/ usage for (i) 57-64/ 66 GHz (V-band) and (ii) 71-76 GHz/ 81-86 GHz (E-band) and accordingly methodology of assignment of spectrum and associated terms & conditions, in line with the determination of scope of services/ usages by TRAI i.e. Access or Backhaul or Integrated Access & Backhaul (IAB).

(b) Feasibility & technical parameters, for allowing low power, indoor, consumer device-to-consumer device usage on license-exempt basis in V-band as referred to in Para 4(d)[89] of the Reference dated 12.08.2022.

(c) Provide any other recommendations deemed fit for the purposes mentioned under (a) to (b) above.

E. Assessment of the Demand of Spectrum in E-band and V-band

3.15 Through the Reference dated 13.09.2024, DoT has provided the following band descriptions of E-band and V-band:

Table 3.1: Band Descriptions of E-band and V-band

Band	Frequency range
E-band	71-76 GHz, and 81-86 GHz
V-band	The V-band is generally referred to as the 57-64 GHz range. The extended V-band is considered to be the 57-66 GHz range.

3.16 As per the National Frequency Allocation Plan (NFAP 2022)[90], the allocation of the frequency ranges of E-band and V-band is as below:

Table 3.2: Allocation of the frequency ranges of the E-band

Frequency Range (GHz)	Services
71-74	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE MOBILE-SATELLITE (space-to-Earth) IND 34
74-76	FIXED FIXED-SATELLITE (space-to-Earth) MOBILE

[89] para 4(d) of the Reference dated 12.08.2022, is reproduced below:
"Feasibility, including technical parameters, for allowing low power, indoor, consumer device-to-consumer device usage 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".

[90] Source: https://dot.gov.in/sites/default/files/NFAP%202022%20Document%20for%20e-release.pdf

Frequency Range (GHz)	Services
	BROADCASTING BROADCASTING-SATELLITE Space research (space-to-Earth) 5.561 IND 34
81-84	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 IND34
84-86	FIXED 5.338A FIXED-SATELLITE (Earth-to-space) MOBILE RADIO ASTRONOMY 5.149 IND34

Table 3.3: Allocation of the frequency ranges of the V-band

Frequency Range (GHz)	Services
57-58.2	EARTH EXPLORATION-SATELLITE (passive) IND35 FIXED IND 35 INTER-SATELLITE 5.556A MOBILE 5.558 SPACE RESEARCH (passive) 5.547
58.2-59	EARTH EXPLORATION-SATELLITE (passive) IND 35 FIXED IND 35 MOBILE SPACE RESEARCH (passive) 5.547 5.556 IND 35
59-59.3	EARTH EXPLORATION-SATELLITE (passive) IND 35 FIXED IND 35 INTER-SATELLITE 5.556A MOBILE 5.558 RADIOLOCATION 5.559 SPACE RESEARCH (passive)
59.3-64	FIXED IND 35 INTER-SATELLITE MOBILE 5.5558 RADIOLOCATION 5.559 5.138 IND 35

Frequency Range (GHz)	Services
64-65	FIXED INTER-SATELLITE MOBILE except aeronautical mobile 5.547 5.556 IND 35
65-66	EARTH EXPLORATION-SATELLITE IND 35 FIXED INTER-SATELLITE MOBILE except aeronautical mobile SPACE RESEARCH 5.554

3.17 Through the Reference dated 13.09.2024, DoT has provided, *inter-alia*, the following details in respect of the developments in E-band and V-band:

"3.1 The V-band (57-64/ 66 GHz) is a part of the band n263 of 3GPP (57 GHz to 71 GHz), which is also referred to as 60 GHz band. That is to say that the complete 57-71 GHz band has been planned by 3GPP as IMT/ Access band. Point to point (backhaul) solutions are also available in the V band. Further, a part of this band, i.e., 66-71 GHz, has already been identified by ITU globally for IMT based Access services in WRC-19."

3.2 The E-Band (71-76 GHz/ 81-86 GHz) has already been assigned LSA-wise for Backhaul purpose to TSPs on provisional basis, during 2022. One of the commercial telecom service providers, holding UL with Access service authorisation, has sought permission for using this band for Access Services, in addition to the Backhaul purposes. i.e. as IAB (Integrated Access & Backhaul). In addition, another service provider, holding UL with Internet service authorisation (ISP) has sought E/V band spectrum for last mile connectivity purpose.

3.18 As indicated by DoT in the Reference dated 13.09.2024, DoT has assigned upto two carriers of 250 MHz (paired) bandwidth in E-band to wireless access service

providers as an interim measure for backhaul use on a provisional basis[91]. No assignments have been made in the V-band so far in the country for radio backhaul purposes.

3.19 Through the Reference dated 13.09.2024, DoT has requested TRAI to determine the scope of service/ usage of E-band and V-band and to provide recommendations on the methodology for the assignment of spectrum and associated terms and conditions in line with the determination of scope of services/ usages by TRAI i.e., Access, or Backhaul, or Integrated Access and Backhaul (IAB). As outlined in Chapter I of this consultation paper, "Access" is the last mile connectivity to consumer devices, and "Backhaul" is the link connecting the access network with the core network[92]. "Integrated Access and Backhaul (IAB)" is a new concept[93] which was introduced by 3GPP in Release 16. A brief description of IAB is given below.

3.20 IAB standardized by 3GPP in Release 16 is aimed to enhance 5G New Radio (NR) capabilities by permitting the wireless backhaul to share the same spectrum as access links. The architecture of an IAB network, as defined by 3GPP Release 16, is depicted in Figure 3.5 below. The network nodes in an IAB network are either 'IAB donors' or 'IAB nodes'. The IAB donors connect to the

[91] DoT issued the 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 July 2022. The DoT's guidelines, *inter-alia*, include the following aspects:
1. TSPs, based upon their application, 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.
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.
10. The applicants (TSPs) are required to submit an undertaking as per enclosed proforma, with their request for the assignment of E- band carriers.
Source: https://dot.gov.in/sites/default/files/Guidelines%20for%20allotment%20of%20E-band%20dated%2025%2007%202022%20signed.pdf

[92] ITU, in the 'Terms and Definitions for Network 2030'[92], has defined "access network" as the last mile connectivity to the consumer device. It may be mobile radio, copper, fibre, satellite or terrestrial floating network. The backhaul may be considered as a hand-off layer between access and transport/core network.
Source: https://www.itu.int/en/ITU-T/focusgroups/net2030/Documents/Network_2030_Terms_and_Definitions.pdf

[93] ITU, in its Report on 'Future technology trends of terrestrial International Mobile Telecommunications systems towards 2030 and beyond', has noted that in future, IAB should be considered as a critical axis of ultra-dense radio access networks; IAB can facilitate replacing fibre optics with wireless, and could reduce both capital expenditures and operating expenses of backhaul links. Source: https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2516-2022-PDF-E.pdf

core network with OFC and can provide wireless access services to mobile users as well as wireless backhauling to IAB nodes. The IAB nodes provide wireless access services to mobile users and wireless backhauling to other IAB nodes as well.[94]

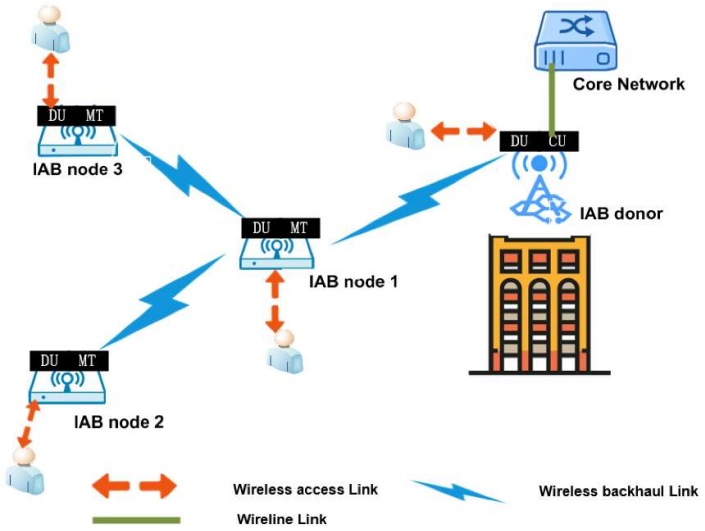


Figure 3.5: Architecture of Integrated Access and Backhaul (IAB)[95]

3.21 According to 3GPP, the frequency range designation in which 5G new radio (NR) can operate are as below:

(a) FR1 (410 MHz – 7125 MHz),

(b) FR2-1 (24250 MHz – 52600 MHz), and

(c) FR2-2 (52600 MHz – 71000 MHz).

3.22 Further, the 5G NR IAB is designed to operate in the following bands:

(a) n41 (2496-2690 MHz), n77 (3300-4200 MHz), n78 (3300-3800 MHz), and n79 (4400-5000 MHz) of FR1, and

(b) entire FR2-1[96].

[94] Source: https://www.mdpi.com/2078-2489/15/1/19

[95] Ibid

[96] Source: https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3665

3.23 From the frequency range designations of 3GPP for 5G NR and 5G NR IAB, the following may be inferred:

(a) The V-band is covered in the frequency ranges designated for the 5G NR. However, the E-band is not covered.

(b) Neither the E-band nor the V-band is covered in the frequency ranges designated for 5G NR IAB.

3.24 The foregoing description may be tabulated as below:

Table 3.4: Possible Usages of E-band and V-band in 5G Networks as per 3GPP

Band	**5G NR (Access)**	**5G NR IAB (Integrated Access and Backhaul)**
E-band	X	X
V-band	✓	X

3.25 Though E-band and V-band are not covered in the frequency ranges designated for 5G NR IAB, in general, last mile connectivity solutions such as fixed wireless access (FWA) may potentially be provisioned in E-band and V-band in addition to backhaul links on a standalone manner. In the Reference dated 13.09.2024, DoT has mentioned that a service provider holding Unified License with Internet Service authorisation has requested DoT for the allotment of the spectrum in E-band and V-band for last mile connectivity purposes.

3.26 As mentioned in Chapter II of this consultation paper, the last mile connectivity (fixed wireless access) to the customer equipment in telecommunication networks is, essentially, the "Access" part of telecommunications. *Prima facie*, many types of service providers such as access service providers, internet service providers and M2M service providers might require the spectrum in E-band and V-band for the last mile connectivity

(fixed wireless access) to the customer equipment in telecommunication networks i.e. for "Access" purposes.

3.27 Section 4(4) read with the First Schedule of the Telecommunications Act, 2023 provides that the assignment of spectrum for radio backhaul purposes shall be through an administrative process. Further, Section 4(4) of the Telecommunications Act, 2023 provides that *the Central Government shall assign spectrum for telecommunication through auction except for entries listed in the First Schedule*. Considering that the "Access" is an integral part of IAB, the assignment of the spectrum for both "Access" as well as "Integrated Access & Backhaul" will be made through auction in terms of Section 4(4) of the Telecommunications Act, 2023.

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

Issues for Consultation:

Q18. What is the level of demand of the spectrum in the E-band (71-76 GHz, and 81-86 GHz) for each of the service/ usage viz. "Backhaul", "Access" and "Integrated Access & Backhaul (IAB)"? Kindly provide a detailed response in respect of each service/ usage with justification including availability of technical standards and eco-system.

Q19. What is the level of demand of the spectrum in the V-band (57-64/ 66 GHz) for each of the service/ usage viz. Backhaul, Access and IAB? Kindly provide a detailed response in respect of each service/ usage with justification including availability of technical standards and eco-system.

F. Terms and Conditions for the Assignment of the Spectrum in E-band and V-band

3.29 Through the Reference dated 13.09.2024, DoT has requested TRAI to provide recommendations on, *inter-alia*, the methodology for the assignment of spectrum and associated terms and conditions, in line with the determination of scope of services/ usages, i.e., Access, or Backhaul, or IAB.

(1) Band Plans and Carrier Sizes for E-band and V-band

3.30 In the year 2012, ITU issued its recommendation ITU-R F.2006 on 'Radio Frequency Channel and block arrangements for fixed wireless systems operating in the 71-76 and 812-86 GHz bands'[97]. Through the recommendation, ITU recommended several radio frequency channel arrangements in the E-band with a guard band of 125 MHz at the top and bottom of each 5 GHz range (i.e. 71-76 GHz range, and 81-86 GHz range). In the first arrangement, there are 19 FDD channels of 250 MHz each with a duplex separation of 10 GHz between them. In the second arrangement, there are 18 FDD channels of 250 MHz each with a duplex separation of 2.5 GHz between them. In the third arrangement, there is a flexibility to decide about deployment in TDD, FDD, or their mixed use of the band. In short, the ITU recommendation permits both FDD and TDD duplexing and allows several channel arrangements.

3.31 DoT, while making provisional assignments of the spectrum in the E-band to access service providers has adopted the ITU's first channel arrangement viz. 19 FDD channels of 250 MHz each with a duplex separation of 10 GHz between them. This channel arrangement may be depicted as below:

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

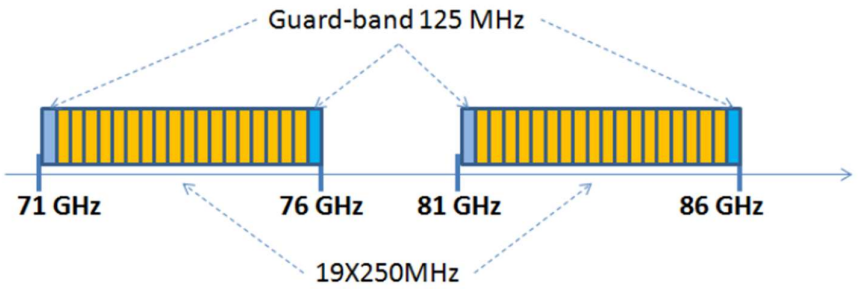


Figure 3.6: The channel plan adopted by India for the provisional assignment of the spectrum in E-band

3.32 In the year 2014, ITU issued its recommendation ITU-R F.1497-2 on 'Radio-frequency channel arrangements for fixed wireless systems operating in the band 55.78-66 GHz[98]. The recommendation permits both FDD and TDD duplexing scheme in the 57-66 GHz range. In respect of the FDD duplex separation, ITU has stated that the FDD duplex separation is not specifically identified; it may be either left free or defined at national level according to the needs.

3.33 In the afore-mentioned recommendation, ITU has divided the 57-64 GHz range into 140 channels of 50 MHz size. ITU has said that channels n=1,2 may be considered as guard band towards the lower band 57.78-57 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 a guard band because the same system might appropriately operate also in the adjacent band.

3.34 In effect, as per the ITU's recommendation, 138 channels of 50 MHz size are available in the V-band for the carriage of traffic in TDD-based configuration. The following figure depicts the channel arrangement in 57-64 GHz range.

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

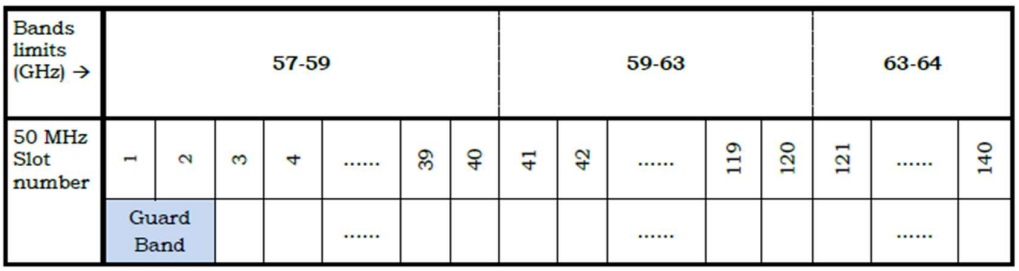


Figure 3.7: Channel Arrangement for the 57-64 GHz range[99]

3.35 In the 64-66 GHz range, ITU has given flexibility of two channel sizes viz. 30 MHz and 50 MHz. With the channel size of 50 MHz, the channel arrangement in the 64-66 GHz range is given below:

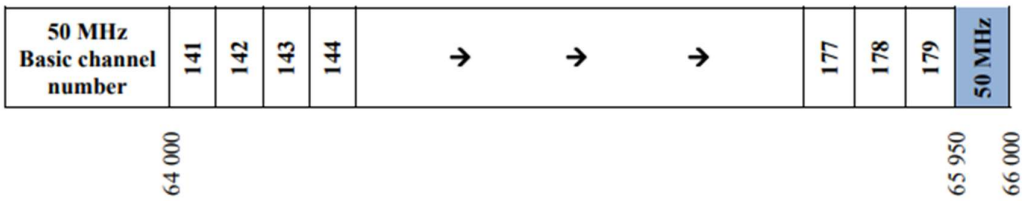


Figure 3.8: Channel Arrangement for the 64-66 GHz range[100]

3.36 While recommending the radio-frequency channel arrangements in the band 64-66 GHz, ITU also mentioned that *"it should be noted that the different amount of oxygen absorption in the 57-64 GHz band and in the 64-66 GHz band may suggest, at a national level, different regulatory provisions between these bands"*.

3.37 With respect to the usage of the V-band for radio backhaul purposes, it needs to be decided as to whether radio backhaul applications should be permitted in the 57-64 GHz range, or in the 57-66 GHz range. In case it is decided that the 57-66 GHz range would be used for radio backhaul purposes, considering that the 66-71 GHz range is already identified for IMT, there might be a need

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

[100] ibid

for provisioning a guard band between the 57-66 GHz range (for radio backhaul purposes), and the 66-71 GHz range (for IMT).

3.38 In India, DoT, has allotted a maximum of two carriers of 250 MHz (paired) bandwidth [i.e., a total of 500 MHz (paired) bandwidth] in the E-band to wireless access service providers for radio backhaul purposes[101] on provisional basis. So far, no spectrum in the V-band has been assigned for radio backhaul purposes.

3.39 It is worth mentioning that TRAI, through the Recommendations dated 29.08.2014, had recommended as below in respect of band plan, carrier size and carrier aggregation in E-band and V-band:

"Channel bandwidth for E-band (71-76 GHz and 81-86 GHz) should be 250 MHz with a guard band of 125 MHz 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 50 MHz with a 100 MHz guard band at the beginning of the band. More than one channel can be allowed and allocated for aggregation."

3.40 The report[102] by GSMA and ABI Research on Wireless Backhaul Evolution (2021) provides a table depicting typical channel size and data throughput in the year 2020 vs. 2027 in E-band and V-band. The relevant extract of the table is given below:

[101] DoT, in its guidelines of July 2022 for the allotment of the spectrum in the E-band has stated, *inter-alia*, as below with respect to the usage of the spectrum in the E-band:
"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."

[102] Source: https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

Table 3.5: Comparison of typical channel size and data throughput in the year 2020 vs. 2027[103]

Main Backhaul Bands	2020		2027	
	Typical Channel Size (MHz)	Data Throughput (Gbps)	Typical Channel Size (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

3.41 In short, GSMA and ABI Research have forecasted that in the year 2027, the typical channel size will be 500 MHz, 1000 MHz or 2000 MHz in the E-band, and 2160 MHz in the V-band. While large channel sizes prevent the fragmentation of the spectrum, smaller channel sizes provide flexibility to telecom service providers. In this background, a question arises as to which band plans and what carrier sizes should be adopted for the spectrum in E-band and V-band in India.

(2) Ceilings on the Number of Carriers in E-band and V-band

3.42 The objective of prescribing a ceiling on the number of carriers that a licensee can hold is to prevent large holdings of carriers by one or a few telecom service providers, which otherwise, may create scarcity of carriers for other service providers including new entrants in the sector.

3.43 As per the DoT's guidelines dated 25.07.2022 for the provisional allotment of E-band carriers, wireless access service providers can seek up to two carriers

[103] Source: https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

of 250 MHz (each) in each LSA for radio backhaul purposes. *Prima facie*, it appears that with the increase in mobile data traffic, wireless access service providers might require more than two carriers in the E-band in an LSA.

3.44 As per the information provided by DoT through the letter dated 08.05.2025, at an aggregate level, two to five carriers have been assigned to access service providers in an LSA. The following table provides the LSA-wise total number of carriers assigned to access service providers in the E-band:

Table 3.6: LSA-wise Total Number of Carriers in the E-band Assigned to Access Service Providers

LSA	Total Number of Carriers in the E-band Assigned to Access Service Providers
Andhra Pradesh	4
Assam	4
Bihar	5
Delhi	5
Gujarat	4
Haryana	4
Himachal Pradesh	2
Jammu and Kashmir	2
Karnataka	4
Kerala	4
Kolkata	4
Madhya Pradesh	4
Mumbai	5
Maharashtra	4
North East	2
Odisha	2
Punjab	4
Rajasthan	4
Tamil Nadu	4

LSA	Total Number of Carriers in the E-band Assigned to Access Service Providers
Uttar Pradesh (East)	4
Uttar Pradesh (West)	2
West Bengal	2

3.45 Considering that 19 carriers of 250 MHz (paired) size are available in the E-band, and 138 carriers, or 178 carriers of 50 MHz unpaired size are available in the V-band depending upon frequency range adoption in V-band (57-64 GHz range, or 57-66 GHz range), a question arises as to what should be the ceilings on the number of carriers in E-band and V-band which may be assigned to a telecom service provider in an LSA.

(3) Method of Assignment of Spectrum in E-band and V-band

3.46 In accordance with the guidelines dated 25.07.2022 for the provisional allotment of E-band carriers, DoT has assigned carriers of the E-band on a block-basis within LSA. It is noteworthy that TRAI, through the Recommendations dated 29.08.2014, had recommended that the spectrum in E-band and V-band should be assigned on a link-to-link basis. The relevant recommendation of the Recommendations dated 29.08.2014 is reproduced below:

"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."

3.47 *Prima facie*, the spectrum in E-band and V-band would be required not only by access service providers but by other types of telecom service providers as well. Further, it appears that a single method for the assignment of the spectrum in E-band and V-band (either on a block-basis, or link-basis, or any other) might not necessarily fit the requirements of all types of telecom service providers.

3.48 In this background, a question arises as to which method (block-basis in an LSA, link-basis, or any other) should be used for the assignment of the spectrum in E-band and V-band for radio backhaul purposes for various commercial telecommunication services.

(4) Validity Period for the Assignment of the Spectrum in E-band and V-band

3.49 As mentioned in Chapter II of this consultation paper, the spectrum in MWA and MWB bands is assigned to access service providers for a period up to the expiry of the service license or the expiry of the access spectrum assignment, whichever is earlier. In case of (a) TSPs other than access service providers and (b) other entities (non-TSP/ non-commercial isolated/ captive users), the microwave spectrum is assigned on an annual basis; upon expiry, the spectrum may be renewed.

3.50 As highlighted in the report[104] on 'Wireless Backhaul Evolution' (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*

[104] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

development, as they can quickly move their links to different bands that have more available spectrum.

3.51 In this background, a question arises as to what should be the validity period for the assignment of the spectrum in E-band and V-band.

(5) Eligibility for Obtaining the Spectrum in E-band and V-band

3.52 As may be seen from the guidelines dated 25.07.2022 for the provisional allotment of E-band carriers, the carriers in the E-band spectrum have been assigned only to wireless access service providers. *Prima facie*, high capacity backhaul spectrum may also be required by other telecom service providers, such as internet service providers and M2M service providers. In this background, a question arises as to what should be the eligibility conditions for obtaining the spectrum in E-band and V-band.

(6) Roll-out Obligations for the Spectrum in E-band and V-band

3.53 For ensuring that the spectrum assigned to telecom service providers in E-band and V-band is put to use in a timely and efficient manner, there could be a need for prescribing roll-out obligations on the lines of the roll-out obligations for the access spectrum.

(7) Surrender of the Spectrum in E-band and V-band

3.54 As mentioned in Chapter II of this consultation paper, DoT has already issued guidelines dated 10.11.2022 for the surrender of administratively assigned frequency carriers (GSM/ CDMA/ MW Access and MW backbone). Apparently, an enabling policy would be required for surrendering the excess spectrum in E-band and V-band as well.

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

Issues for Consultation:

Q20. For which commercial telecommunication services should the spectrum in E-band and V-band be assigned for radio backhaul purposes? Responses with detailed justifications may kindly be provided for E-band and V-band separately.

Q21. Which of the following methods should be used for the assignment of the spectrum in E-band and V-band for radio backhaul purposes for various commercial telecommunication services:

(a) Block-basis in LSA;

(b) Point-to-point link-basis; or

(c) Any other?

Responses with detailed justifications may kindly be provided for E-band and V-band separately in respect of the relevant commercial telecommunication services.

Q22. In case it is decided to use different methods (block-based, link-based, or any other) for the assignment of the spectrum in E-band and/ or V-band for radio backhaul purposes for different types of commercial telecommunication services, how much spectrum in E-band and V-band should be earmarked for the point-to-point link-based assignment for radio backhaul purposes for commercial telecommunication services? Responses with justifications may kindly be provided for E-band and V-band separately.

Q23. What should be the terms and conditions for the assignment of the spectrum in the E-band for radio backhaul purposes of commercial telecom services such as-

(i) Band plan;

(ii) Carrier size;

(iii) Carrier aggregation;

(iv) Validity period of the assignment;

(v) Renewal mechanism;

(vi) Surrender of the spectrum;

(vii) Ceiling on the number of carriers (spectrum cap);

(viii) Criteria for the assignment of additional spectrum above the ceiling limit; and

(ix) Roll-out obligations etc.?

Kindly provide a detailed response with justifications.

Q24. What frequency range (57-64 GHz, or 57-66 GHz) in the V-band should be adopted for radio backhaul purposes? In case you are of the opinion that the 57-66 GHz range should be adopted for radio backhaul purposes, considering that the 66-71 GHz range is already identified for IMT, whether there is a need for provisioning a guard band between the 57-66 GHz range (for the backhaul purposes) and the 66-71 GHz range (for IMT)? If yes, what should be the guard band? Kindly provide a detailed response with justifications.

Q25. What should be the terms and conditions for the assignment of the spectrum in the V-band for radio backhaul purposes of commercial telecom services including the following aspects:

(i) Band plan;

(ii) Carrier size;

(iii) Carrier aggregation;

(iv) Validity period of the assignment;

(v) Renewal mechanism;

(vi) Surrender of the spectrum;

(vii) Ceiling on the number of carriers (spectrum cap);

(viii) Criteria for the assignment of additional spectrum above the ceiling limit; and

(ix) Roll-out obligations etc.?

Kindly provide a detailed response with justifications.

Q26. In case it is decided to earmark a few carriers in E-band and/ or V-band for services/ usages as "Access" and/ or "Integrated Access & Backhaul (IAB)", -

(a) What quantum of spectrum in E-band and V-band should be earmarked for such services/ usages?

(b) What should be the eligibility conditions to obtain the spectrum in E-band and V-band for such services/ usages?

(c) What should be the terms and conditions for the assignment of spectrum in E-band and V-band through auction such as-

(i) Block size;

(ii) Minimum quantity for bidding;

(iii) Spectrum cap;

(iv) Validity period of the assignment;

(v) Roll-out obligations; and

(vi) Surrender of spectrum etc.?

(d) Should flexible use [i.e., radio backhaul, and last mile connectivity (fixed wireless access) to the customer equipment] be permitted in frequency ranges earmarked in E-band and/ or V-band for such services/ usages? If yes, should the terms and conditions of the auction of spectrum be the same as those applicable for "access spectrum"?

Responses with detailed justifications and international practices may kindly be provided for E-band and V-band separately.

G. Non-commercial/ Captive Usage of the Spectrum in E-band and V-band for Radio Backhaul Purposes

3.56 As mentioned in Chapter II of this consultation paper, at present, DoT assigns microwave carriers for backhaul purposes in traditional microwave backhaul bands to non-TSP entities for their non-commercial/ captive usages on a point-to-point link basis for a period of one year, with the provision for renewal of the assignment. Through the Reference dated 13.09.2024, DoT has requested TRAI to provide recommendations on quantum/ bands to be earmarked for backhaul purposes for non-commercial/ captive use and associated terms and conditions including charges.

3.57 In this background, the Authority solicits comments from stakeholders on the following questions:

Q27. Whether there is a need for earmarking certain quantum of spectrum in E-band and V-band for point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users? If yes,-

(a) What quantum of spectrum in E-band and V-band should be earmarked for such purposes?

(b) What should be the terms and conditions for the assignment of spectrum such as:

(i) Carrier size;

(ii) Carrier aggregation;

(iii) Ceiling on the number of carriers;

(iv) Validity period of the assignment;

(v) Renewal mechanism;

(vi) Criteria for the assignment of additional spectrum above the ceiling limit;

(vii) Roll out obligations; and

(viii) Surrender of the spectrum etc.?

Responses with detailed justifications may kindly be provided for E-band and V-band separately.

Q28. In case your response to Q27 is 'no', in what manner should the point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users be fulfilled? Kindly provide a detailed response with justifications.

G. Feasibility of allowing low power usages on a license-exempt basis in the V-band (57-64/66 GHz)

3.58 DoT through the Reference dated 13.09.2024, has requested TRAI to provide recommendations on *feasibility and technical parameters, for allowing low power, indoor, consumer device-to-consumer device usage on license-exempt basis in V-band as referred to in Para 4(d) of reference dated 12-08-2022.*

3.59 In this regard, para 4(d) of the Reference dated 12.08.2022 is reproduced below:

"Feasibility, including technical parameters, for allowing low power, indoor, consumer device-to-consumer device usage 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".

3.60 DoT, in the Reference dated 12.08.2022, had mentioned that *"[i]n 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."

3.61 In effect, DoT, through the Reference dated 13.09.2024, has requested TRAI to provide recommendations on the feasibility and technical parameters, for allowing low power, indoor, consumer device-to-consumer device usage on license-exempt basis in the V-band, in parallel to the use of the spectrum by telecom service providers for the establishment of terrestrial networks in a part or full V-band.

3.62 In 2018, ITU issued its recommendation[105] on 'Multiple Gigabit Wireless Systems in frequencies around 60 GHz'. Multiple Gigabit Wireless Systems (MGWS) radiocommunication networks can be used in short-range, line-of-sight (LOS) and non-line-of-sight (NLOS) circumstances with traditional wireless local area network (WLAN) topologies. 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. Salient points of the ITU's recommendation are given below:

(a) WLAN: For WLAN, 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.

[105] https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2003-2-201801-I!!PDF-E.pdf

(b) WPAN: For proximity communication, performance up to 100 Gbps is expected with a range of 10 cm or less (devices nearly touching) with transient connections (rapid setup and teardown). In some applications, nomadic devices connect with stationary devices (i.e. kiosk, doorway, turnstile, vending machine) for a very short duration to transfer large amounts of data, e.g. download two hours of HD video content in 250 milliseconds while passing through an entry turnstile at a train station or airport.

3.63 The key points of the ITU's recommendation with respect to the use of spectrum in the V-band for MWGS are given below:

(a) To satisfy the requirements of MWGS, a minimum of 7 GHz contiguous spectrum in the 57-71 GHz is needed.

(b) A channel bandwidth of 2.16 GHz is required for single channels. Bonding of single channels is allowed.

(c) 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.

3.64 In the Reference dated 13.09.2024, DoT has mentioned the frequency range of the V-band as 57-64/ 66 GHz. In the 57-66 GHz frequency range, the following four channels of 2.16 GHz (as recommended by ITU in its recommendations on MGWS) may be considered for MWGS:

Table 3.7: Frequency channels in 57-66 GHz range for MGWS

Channel	Start Frequency (GHz)	Centre Frequency (GHz)	End Frequency (GHz)
1.	57.24	58.32	59.40
2.	59.4	60.48	61.56
3.	61.56	62.64	63.72
4.	63.72	64.80	65.88

3.65 In India, DoT has delicensed 500 MHz of spectrum in the V-band (i.e. 61-61.5 GHz range) for the use of low power and very low power short range radio frequency devices in 2018[106]. The transmit power limit for such devices is 100 mW eirp[107].

3.66 In this context, the Authority perused the prevalent regulatory regimes in other countries with respect to the delicensed usage of the V-band. A brief description of the practices being followed in a few countries on the matter is given below:

(1) United States of America (USA)

3.67 In USA, the Part 15 rules[108] permit low-power intentional radiators (popularly known as "unlicensed devices") to operate without an individual license where such use is not anticipated to cause harmful interference to authorized users of the radio spectrum[109]; unlicensed devices in the 57-71 GHz band generally include indoor/ outdoor communication devices such as WiGig[110] wireless local area networking (WLAN) devices, outdoor fixed point-to-point communication links, and field disturbance sensors (FDS) – which includes radar operations. Section 15.255 (Operation within the band 57-71 GHz) of the Part 15 rules

[106] DoT has delicensed, *inter-alia*, the 61-61.5 GHz range through the 'Use of Low Power and Very Low Power Short Range Radio Frequency Devices (Exemption from Licensing Requirement) Rules, 2018' dated 18.10.2018
Source: DoT's G.S.R. 1047(E) dated 18.10.2018, accessible at the following URL:
https://dot.gov.in/sites/default/files/License%20Exemption%20for%20SRD%20Device%20G_S_R_1047%28E%29%20dated%2018th%20October%2C%202018_1.pdf?download=1

[107]The devices are required to comply with EN 305 550 standard for effective use of spectrum and to avoid harmful interference.

[108] The term "Part 15 rules" refers to Part 15 (Radio Frequency Devices) of subchapter-A (General) of Chapter I (Federal Communications Commission) of Title 47 (Telecommunications) of the Code of Federal Regulations of USA.

[109] The fundamental operating conditions under Part 15 are that the operator of a Part 15 device has no vested right to continued use of any given frequency, must accept interference that may be caused by the operations of authorized users or other unlicensed devices, and must not cause harmful interference it causes. Should harmful interference occur, the operator is required to immediately correct the interference problem, even if correction of the problem requires ceasing operation of the part 15 equipment causing interference.

[110] WiGig, alternatively known as 60 GHz Wi-Fi, refers to a set of 60 GHz wireless network protocols. It includes the current Institute of Electrical and Electronics Engineers (IEEE) IEEE 802.11ad standard and also the IEEE 802.11ay standard. The name WiGig comes from Wireless Gigabit Alliance, the original association being formed to promote the adoption of IEEE 802.11ad. However, it is now certified by Wi-Fi Alliance.

mandates that within the 57-71 GHz band, emission levels shall not exceed the following equivalent EIRP[111]:

Device Type	Power Limits
Devices other than field disturbance sensors	(i) The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm; or (ii) For fixed point-to-point transmitters located outdoors, the average power of any emission shall not exceed 82 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.
Field disturbance sensors/ radars	Shall not exceed −10 dBm peak conducted output power and 10 dBm peak EIRP except that field disturbance sensors/ radars that limit their operation to all or part of the specified frequency band may operate without being subject to a transmitter conducted output power limit if they operate in specific frequencies, for which separate EIRP levels have been defined.

3.68 Unlicensed device users must account for the operations of authorized Federal and non-Federal users in the band, who operate under a variety of co-primary allocations. These allocations, which vary by band segment, consist of the Mobile, Fixed, Inter-Satellite, Earth-Exploration Satellite Service (EESS), Space Research, Mobile-Satellite, Radiolocation, Radionavigation, and Radionavigation-Satellite services.[112]

[111] Source: https://www.ecfr.gov/current/title-47/chapter-I/subchapter-A/part-15/subpart-C/subject-group-ECFR2f2e5828339709e/section-15.255

[112] Source: https://docs.fcc.gov/public/attachments/DOC-373482A1.pdf

(2) United Kingdom (UK)

3.69 In UK, the 57-71 GHz band can be used to provide wireless access solutions (e.g. small base stations fixed to a lamppost) or to provide wireless backhaul (e.g. point to point links). These can be used to provide broadband services or help to connect a variety of other technologies such as Internet of Things (IoT) or Machine-to-Machine (M2M) networks. The authorisation needed to use the 57–71 GHz band varies depending on the equipment being used as outlined below:

(a) Licence-exempt low power use- No license is required for the usage of the spectrum in the 57-71 GHz range at or below 40 dBm EIRP.[113]

(b) Licensed outdoor use- The "Spectrum Access: EHF license" is required for the outdoor usage of the spectrum in the 57-71 GHz range above 40 dBm EIRP upto 55 dBm EIRP.[114]

(3) Australia

3.70 Australian Communications and Media Authority (ACMA) through Radiocommunications (Low Interference Potential Devices) Class Licence 2015[115] has authorised use of Low Interference Potential Devices (LIPDs) on shared frequencies, *inter-alia*, in the frequency ranges 57–71 GHz for which there is no need to apply for a licence or pay any fees. The technical conditions on various transmitters permitted in the 57-71 GHz range are given below:

[113] For Wideband Data Transmission System (WBDTS), Equipment must not form part of a fixed outdoor installation. Equipment may be used airborne. Source: Ofcom's IR 2030 – UK Interface Requirements 2030- Licence Exempt Short Range Devices (SRDs), accessible at https://www.ofcom.org.uk/siteassets/resources/documents/spectrum/interface-requirements/ir-2030.pdf?v=335258

[114] Power limits on outdoor use: 55 dBm EIRP, 38 dBm/MHz EIRP density and a transmit antenna gain ≥ 30 dBi Source: Spectrum Access: EHF Licence- Licensing guidance document, accessible at https://www.ofcom.org.uk/siteassets/resources/documents/manage-your-licence/spectrum-access-ehf/spectrum-access-ehf-licence-guidance.pdf?v=325307

[115] https://www.legislation.gov.au/F2015L01438/2023-03-02/text

Class of transmitter	Frequency band (MHz)	Maximum EIRP	Main technical conditions
All transmitters	57000-71000	100 mW	(a) The maximum transmitter power must not exceed 10 mW. (b)The maximum radiated power spectral density must not exceed 13dBm per 1 MHz.
Data communications transmitters	57000-71000	20 W	The transmitter must comply with FCC Rules Title 47 Part 15 Section 255[116].
Data communications transmitters used outdoors	59000–63000	150 W	(a) The transmitter must not be operated on board an aircraft. (b) The maximum transmitter power must not exceed 20 mW. (c) The transmitter must not cause spurious emissions outside the band at or greater than –30 dBm/MHz. (d) The transmitter must only be used outdoors.
Fixed point-to-point links used outdoors	57000-71000		The transmitter must comply with FCC Rules Title 47 Part 15 Section 255.

[116] https://www.ecfr.gov/current/title-47/section-15.255

(4) New Zealand

3.71 In New Zealand, the government has allowed the following two general user licenses in the 57-71 GHz range:

(a) General User Radio Licence for Fixed Radio Link Devices (GURL-FRLD)[117]

(b) General User Radio Licence for Short Range Devices (SRDs)[118]

3.72 A general user licence lets people use particular types of radio transmitters without needing a licence of their own. General user licences are free of charge.[119]

3.73 Under the afore-mentioned general use licenses, the frequency use is on a shared basis. Any person using frequencies in the 57-71 GHz range must not cause intentional harmful interference to licensed services operating in the 57-71 GHz range.

(5) Singapore

3.74 In March 2011, The Infocomm Development Authority (IDA), Singapore issued a Decision outlining the regulatory framework for the 60 GHz frequency

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[117] Any person may transmit radio waves in the 57-71 GHz range using Fixed Radio Link Devices, including those known as U-NII devices, using digital modulation techniques to typically provide high data rate fixed point-to-point communications. However, point-to-multipoint systems, omni-directional applications and multiple co-located transmitters transmitting the same information are not permitted.
The power limit under General User Radio Licence for Fixed Radio Link Devices is 55 dBm with the following conditions:
(a) Transmitter peak power must not exceed –3 dBW (500 mW) and the power spectral density must not exceed –10 dBm/MHz. For emission bandwidths less than 100 MHz, the transmitter peak power of –3 dBW (500 mW) must be prorated by (bandwidth (MHz) / 100 (MHz)).
(b) The peak power of any emission must not exceed 55 dBW e.i.r.p., or minus 2 dB for every dB that the antenna gain is less than 51 dBi. The average power of any emission shall not exceed 52 dBW e.i.r.p., or minus 2 dB for every dB that the antenna gain is less than 51 dBi.
Source: https://gazette.govt.nz/notice/id/2022-go3099

[118] Any person may transmit radio waves in the 57-71 GHz range using Short Range Devices (SRDs), also known as Restricted Radiation Devices (RRDs), Low Interference Potential Devices (LIPDs), or Spread Spectrum Devices (SSDs).
The power limit under General User Radio Licence for Short Range Devices (SRDs) is 13 mW e.i.r.p. A higher power upto 25 dBm is permitted with the following conditions:
(a) For devices transmitting at 10 dBW e.i.r.p. or less, the power spectral density must not exceed -7 dBW/MHz e.i.r.p. and the maximum transmit power must not exceed -3 dBW at the antenna port or ports.
(b) For devices transmitting greater than 10 dBW e.i.r.p., the power spectral density shall not exceed 8 dBW/MHz e.i.r.p and antennas with a gain greater than 30 dBi shall be used.
Source: https://gazette.govt.nz/notice/id/2022-go3100

[119] Source: https://www.rsm.govt.nz/about/our-work/general-user-licences

band[120]. Through the said decision, IDA mandated that the 60 GHz band will be available under two categories of licensing framework as follows:

(a) Licence-exempt (low power devices with EIRP <=40 dBm)

(b) Licenced (high power devices with EIRP >40 dBm)

3.75 A summary of frequency allocations and regulatory framework of IDA, Singapore in respect of the V-band is given below:

Applications	**Authorised Frequency Band**	**RF Output Power**	**Key Requirements**
MGWS WPAN/ WLAN	57-66 GHz	Not to exceed 40 dBm EIRP	• Indoor use is restricted to a maximum mean EIRP density limit of 13 dBm/MHz • Outdoor use is restricted to a maximum EIRP of 25 dBm and a maximum EIRP power spectral density of -2 dBm/MHz
Point-to-Point fixed wireless systems including fixed LAN extension (FLANE) applications[121]	57.1-62.9 GHz[122]	Not to exceed 55 dBm EIRP	• Equipment is not allowed on aircraft or satellites • Minimum antenna gain of +30 dBi and maximum transmitter output power of +10 dBm • Maximum transmit output power density is limited to -10dBm/MHz

3.76 IDA, Singapore in its decision also mentioned that *"[w]here these devices are used to form a wide area network for service provisioning to third parties, applications shall have to apply for FBO or SBO licenses."*[123]

[120] https://www.imda.gov.sg/regulations-and-licences/regulations/consultations/consultation-papers/2016/consultation-on-proposed-regulatory-framework-for-60-ghz-frequency-band

[121] In the decision, IDA mentioned that high radiation equipment (>40 dBm EIRP) may be permitted only in the 57-63 GHz frequency band in view of future Intelligent Transport System ("ITS") deployed in the 63-64 GHz band.

[122] Excluding guard bands of 100 MHz at each end of the spectrum

[123] FBO and SBO are acronyms of "Facilities-Based Operators" and "Service-Based Operators" respectively.

3.77 The study of the international scenario presented above may be summarized as below:

(a) Delicensed usage of the spectrum in low-power short-range devices: USA, UK, New Zealand, Australia and Singapore have permitted low-power short-range devices (with specified power limits) on a license-exempt basis in the V-band.

(b) Delicensed usage of the spectrum in point-to-point fixed links: USA, UK, New Zealand, Australia and Singapore have permitted point-to-point fixed links (with specified power limits) in the V-band on a license-exempt basis without causing harmful interference to licensed users in the band.

(c) Licensed usage of the spectrum: UK and Singapore have a licensed regime for wireless systems operating with higher power (EIRP between 40 dBm and 55 dBm) in the V-band.

3.78 As mentioned above, DoT, through the Reference dated 13.09.2024, has sought the recommendations of TRAI on the feasibility and technical parameters, for allowing low power, indoor, consumer device-to-consumer device usage on license-exempt basis in the V-band, in parallel to the use of the spectrum by telecom service providers for the establishment of terrestrial networks in a part or full V-band. As far as the indoor usage of the spectrum is concerned, the Authority notes that the term "Indoor" has been defined by many regulators. The definitions of the term "indoor" given by ACMA, Singapore and Ofcom, UK are given below:

(a) As per ACMA, Singapore, *"indoors means a space that is: (a) enclosed by permanent walls on all sides, a permanent roof and a permanent floor; and (b) permanently fixed to a location."*[124]

(b) As per Ofcom, UK, *"Indoor" means inside premises which: (i) have a ceiling or a roof; and (ii) except for any doors, windows or passageways,*

[124] Radiocommunications (Low Interference Potential Devices) Class Licence 2015, Accessible at the following URL: https://www.legislation.gov.au/F2015L01438/latest/text

are wholly enclosed. For example, a tent or an open-air stadium would be considered outdoor settings.[125]

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

Issues for Consultation:

Q29. Whether it is feasible to allow low power indoor consumer device-to-consumer device usages on a license-exempt basis in the V-band in parallel to the use of the spectrum by telecom service providers for the establishment of terrestrial networks in a part or full V-band? Kindly provide a detailed response with justification and international scenario.

Q30. In case it is decided to allow low power indoor consumer device-to-device usages on a license-exempt basis in the V-band (57-64/66 GHz), -

(a) Should it be permitted in the entire V-band or only in a portion of the V-band? If it should be permitted only in a portion of the V-band, please specify the frequency range.

(b) In case it is decided to permit low power indoor consumer device-to-device usages on a license-exempt basis in the entire V-band, whether the 57-64 GHz range, or the 57-66 GHz range should be considered for such usages?

(c) What should be the carrier size/ channel bandwidth?

(d) What should be the definition of indoor usages?

[125] Ofcom's Spectrum Access: EHF Licence Licensing guidance document (May, 2021), accessible at the following URL: https://www.ofcom.org.uk/siteassets/resources/documents/manage-your-licence/spectrum-access-ehf/spectrum-access-ehf-licence-guidance.pdf?v=325307
The said document provides that *"[a]ny device operating in an environment which does not meet the definition of "indoor" is required to meet the technical conditions for outdoor use."*

(e) What technical parameters should be prescribed, including EIRP limits for low power indoor consumer device-to-device usages?

Kindly provide a detailed response with justifications and international scenario.

Q31. Whether there is a need for permitting "outdoor" usages of V-band on a license-exempt basis? Kindly provide a detailed response with justification and international scenario.

Q32. If the response to the Q31 is in the affirmative, whether it is feasible to allow outdoor usages on a license-exempt basis in the V-band in parallel to the use of the spectrum by telecom service providers for the establishment of terrestrial networks in a part or full V-band? Kindly provide a detailed response with justification and international scenario.

Q33. In case it is decided to allow outdoor usages on a license-exempt basis in the V-band (57-64/ 66 GHz), -

(a) Should it be permitted in the entire V-band or only in a portion of the V-band? If it should be permitted only in a portion of the V-band, please specify the frequency range.

(b) In case it is decided to permit outdoor usages on a license-exempt basis in the entire V-band, whether the 57-64 GHz range, or the 57-66 GHz range should be considered for such usages?

(c) What should be the carrier size/ channel bandwidth?

(d) What technical parameters should be prescribed, including EIRP limits for low power indoor consumer device-to-device usages?

Kindly provide a detailed response with justifications and international scenario.

Q34. Any other suggestions relevant to the assignment of the spectrum in E-band (71-76/ 81-86 GHz) and V-band (57-64/ 66 GHz) may kindly be made with detailed justifications.

3.80 The following chapter examines the issues relating to spectrum charges and valuation of the microwave spectrum in 6 GHz (lower), & GHz, 13 GHz, 15 GHz, 18 GHz bands, 21 GHz, E-band and V-band.

Chapter IV: Issues Related to Spectrum Charges and Valuation of Spectrum

I. Spectrum Charging and Valuation of Spectrum of Microwave bands

A. Background

4.1 The microwave spectrum is the lifeblood of today's cellular mobile networks worldwide. It is used for providing both cellular mobile radio access and backhaul. Conventionally, the microwave spectrum ranging from 400 MHz to 4 GHz was used for providing cellular mobile radio access, while the microwave spectrum ranging from 6 GHz to 24 GHz was used for providing the backhaul.

4.2 As per GSMA report[126] on "Spectrum for Wireless Backhaul" –

"Current backhaul bands will still play an important role but need support to maintain relevance in the 5G era especially through wider channel sizes.

Regulators need to carefully consider the most effective backhaul licensing terms approaches, terms and conditions.

High backhaul spectrum prices present a barrier to mobile network evolution, improved coverage and more spectrum efficient backhaul technologies.

Regulators should, in consultation with the industry, ensure the timely availability of a sufficient amount of affordable backhaul spectrum under reasonable licensing approaches, terms and conditions".

[126] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2021/02/wireless-backhaul-spectrum-positions.pdf

4.3 A well-designed spectrum charges framework can enhance efficiency, promote investment in backhaul infrastructure, and maintain affordability for telecom operators. Optimally structured spectrum fees can strike a balance between cost efficiency and network expansion, ensuring the long-term reliability and sustainability of backhaul services.

4.4 It is important to note that fibre continues to be the gold standard for backhaul, owing to its substantial data capacity.[127] Wired access backhaul offers several advantages over wireless alternatives, including higher bandwidth, lower latency, greater reliability, and enhanced security. Given these benefits, it is essential that the spectrum charges for microwave backhaul bands are structured in a manner that also incentivizes investment in fibre infrastructure. This would encourage service providers to adopt an optimal mix of wired and wireless backhaul solutions.

B. DoT's reference dated 13.09.2024: Spectrum Charging/Pricing in 6 (lower)/7/13/15/18/21 GHz bands.

4.5 Through the letter dated 13.09.2024, DoT requested TRAI to provide its recommendations under Section 11(1)(a) of the TRAI Act, 1997 on certain aspects. The relevant extract of the Reference dated 13.09.2024 regarding 6 (lower) / 7/ 13/ 15/ 18/ 21 GHz bands is reproduced below:

…b) Spectrum charges and related terms & conditions such as spectrum cap, carrier aggregation, etc. for assignment of spectrum in 6 (lower)/7/13/15/18/21 GHz bands for backhaul purposes of commercial telecom services.

……..

[127] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2021/02/wireless-backhaul-spectrum-positions.pdf

(d) Quantum/ band(s) of spectrum to be earmarked for last mile connectivity (Fixed Wireless Access) of commercial telecom services and methodology of assignment of spectrum and associated terms & conditions in non-IMT bands as referred to in Para 2.2 above.

(e) Quantum/ band(s) of spectrum to be earmarked for Backhaul purposes for non- commercial/ captive use and associated terms & conditions including charges as referred to in Para 2.3 above….

4.6 Further, DoT has stated that:
"While the upper 6 GHz band (not part of this reference) i.e., 6.425-7.125 GHz has been identified for IMT in other parts of the world, the lower 6 GHz band i.e. 5.925 to 6.425 GHz continues to be used as backhaul."

4.7 DoT, through a letter dated 08.05.2025, as mentioned in Chapter II, Section F, titled "Delicensed Use of the 6 GHz (lower) Band," has informed that it "*has decided to de-license the lower 6 GHz band (5925-6425 MHz) for low power applications. Relevant rules are under consideration in the Department for notification*." In this regard, DoT, on 16.05.2025, has circulated draft rules for public consultation by the name (draft) "Use of Low Power and Very Low Power Wireless Access System including Radio Local Area Network in Lower 6 GHz band (Exemption from Licensing Requirement) Rules, 2025".

4.8 The Authority notes that, as per the National Frequency Allocation Plan (NFAP) 2022, the 6 GHz (lower) band is allocated on a primary basis to three services, viz. Fixed Service, Fixed Satellite Service (Earth-to-space) and Mobile Service. including its use for radio backhaul purposes. Accordingly, spectrum charges need to be determined for the assignment of the 6 GHz (lower) band for backhaul use.

4.9 In the Reference, DoT has further stated that:

"The spectrum band 7.125 to 8.400 GHz (7 GHz) & 14.8-15.35 GHz (15 GHz) are being considered for IMT i.e. Access, under agenda items 1.7 of WRC-2027."

DoT has requested TRAI to provide recommendations on "*any need for review in respect of use of 7/15 GHz bands in view of consideration of these bands for Access using IMT after WRC-27."*

4.10 In response to the above, under Section B of Chapter II titled "Need for a Review of the Usage of 7 GHz and 15 GHz Microwave Backhaul Bands" of this Consultation Paper, the Authority is examining the need to review the usage of 7 GHz and 15 GHz microwave backhaul bands at this stage, or after considering the outcome of WRC-27.

C. Spectrum Charges for Microwave bands viz. 6 (lower)/7/13/15/18/21 GHz bands for backhaul purposes of commercial telecom services

Present charging mechanism

4.11 At present, spectrum charges for Microwave Access (MWA) and Microwave Backbone (MWB) for commercial Telecom Services are prescribed as per DoT's O.M.s No. J-14025/200(11)-NT dated 03.11.2006 and No. J-14025/200(11)/06-NT dated 10.11.2008 on provisional basis for the interim period. The detailed orders are attached as Annexure 4.1 and Annexure 4.2. The said orders are summarized below:

(i) Charging for Microwave Access (MWA) and Microwave Backbone (MWB) spectrum assignments is done on percentage of Adjusted Gross Revenue (AGR) basis depending on the number of carriers allocated.

(ii) As per above said DoT order, the following revenue share percentage(s) is levied for assignment of microwave networks of telecom service providers.

Spectrum Bandwidth	***Cumulative spectrum charge as % of AGR***
First carrier of 28 MHz (paired)	*0.15%*
2nd carrier of 28 MHz (paired)	*0.35%*
3rd carrier of 28 MHz (paired)	*0.55%*
4th carrier of 28 MHz (paired)	*0.80%*
5th carrier of 28 MHz (paired)	*1.10%*
6th carrier of 28 MHz (paired)	*1.45%*
7th carrier of 28 MHz (paired)	*1.85%*
8th carrier of 28 MHz (paired)	*2.30%*
9th carrier of 28 MHz (paired)	*2.80%*
10th carrier of 28 MHz (paired)	*3.35%*
11th carrier of 28 MHz (paired)	*3.95%*

(iii) The above spectrum charges (as percentage of AGR) are applicable for both MW access carriers (in Metros and other telecom service areas) as well as the MW backbone carriers separately. These charges include the royalty charges for spectrum usages and licence fee for the fixed stations in the MW access and MW backbone links.

(iv) As per the DoT orders cited above, 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. However, for simplicity of calculations the revenue share is based on the AGR for complete service area.

TRAI's earlier Recommendations on "Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers" dated 29.08.2014

4.12 The Authority in its recommendation dated 29th August 2014 on "Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers"[128] had recommended the following: -

> *The assignment of MWA carriers should be done on an exclusive basis for the various spectrum bands in 13-42 GHz range whereas the assignment of MWB carriers should be done on a link-to-link basis.*
> *5.6 The assignment of MWA and MWB carriers should continue to be done administratively.*
> *5.7*
> *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.*
>
> *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.*

[128] https://trai.gov.in/sites/default/files/2024-09/MW%20Reco%20Final29082014.pdf

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%*

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.

If 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.

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

Present 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.

4.13 In 2014, the Authority determined the spectrum charges for MWB links by using the cost of laying Optical Fiber Cable (OFC) as a proxy. The Authority, through

the Telecom Tariff (57th Amendment) Order dated 14th July 2014, notified revised ceiling tariffs for domestic leased circuits (DLC) which was used as a reference for determining microwave backbone (MWB) link charges.

4.14 The Authority in its recommendation dated 29.08.2014 recommended spectrum charge for MWA and MWB links be levied on AGR basis (per carrier / block basis for the entire licensed service area) and per km basis (link-to-link) respectively. However, notwithstanding the said TRAI's recommendations, DoT continues to levy the spectrum charges for MWA and MWB bands on AGR basis (per carrier / block basis for the entire Licensed Service Area) as per its 2006 and 2008 OMs as summarized in the table at para (ii) of 4.11 above.

Examination of issues for 6 (lower)/7/13/15/18/21 GHz bands for backhaul purposes of commercial telecom services

4.15 In view of para 4.14 mentioned above, there is a need to examine the prevailing spectrum charging framework and determine whether spectrum charges for microwave bands should continue to be levied on a block basis for the entire Licensed Service Area (LSA) or be revised to a link-to-link basis.

4.16 As mentioned in the Chapter I of this consultation paper, both backhaul links and backbone links built on microwave spectrum will be referred to as "microwave backhaul", or "radio backhaul", or "wireless backhaul". Accordingly, the same terminology has been adopted in this chapter for consistency.

4.17 As already discussed in paragraphs 4.7 & 4.8 above, DoT, through a letter dated 08.05.2025, has informed that it has decided to delicense the lower 6 GHz band (5925-6425 MHz) for low power applications. However, as per NFAP 2022, the 6 GHz (lower) band is allocated on a primary basis to three services viz. Fixed Service, Fixed Satellite Service (Earth-to-space) and Mobile Service, including its use for radio backhaul purposes, which is not a low power application. Accordingly, spectrum charges need to be determined for the

assignment of the 6 GHz (lower) band for high power applications such as backhaul use.

4.18 Further, DoT has indicated that the 7.125–8.400 GHz (7 GHz) and 14.8–15.35 GHz (15 GHz) bands are being considered for IMT Access under Agenda Item 1.7 of WRC-2027 and has requested TRAI to assess the need for a review of their current use. Considering the present use of 7/15 GHz primarily for backhaul, there exists a current need to examine charges for its backhaul purpose.

4.19 In this background, the Authority seeks comments from stakeholders on the following set of questions:

Issues for Consultation:

Q35. In case the 6 (lower)/7/13/15/18/21 GHz bands for radio backhaul of various commercial telecom services are assigned on a Point-to-Point (P2P) Link basis, should the spectrum charges be levied:

i. As a percentage of Adjusted Gross Revenue (AGR), or

ii. On a per carrier/link basis, or

iii. Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per link/per carrier charge.

Q36. In case the 6 (lower)/7/13/15/18/21 GHz bands for radio backhaul of various commercial telecom services are assigned on a block basis for the entire Licensed Service Area (LSA), should the spectrum charges be levied:

i. As a percentage of Adjusted Gross Revenue (AGR), or

ii. On a per MHz or per carrier basis, or

iii. Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per carrier/ MHz charge.

D. Valuation of microwave bands viz. 6 (lower)/7/13/15/18/21 GHz bands for last-mile connectivity (Fixed Wireless Access) of commercial telecom services

4.20 The previous Section I(C) of this Chapter dealt with the issues relating to the spectrum charging of the spectrum in microwave bands viz. 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands for backhaul purposes of various commercial telecommunication services while the present section deals with the issues relating to the Valuation of microwave bands viz. 6 (lower)/7/13/15/18/21 GHz bands for last-mile connectivity (Fixed Wireless Access) of commercial telecom services

4.21 Through the reference dated 13.09.2024, DoT has informed that "*one of commercial telecom service providers holding Unified License with Access service authorisation and providing wireline services has requested for spectrum in the 6/ 7/ 13 GHz bands for establishing links for last mile connectivity solutions in certain Licensed Service Areas*". Accordingly, TRAI's recommendations have been sought on "*quantum/ band(s) of spectrum to be earmarked for last mile connectivity (Fixed Wireless Access) of commercial telecom services and methodology of assignment of spectrum and associated terms & conditions in non-IMT bands*."

4.22 In Chapter II, the Authority is examining the issue of whether there is a need to earmark certain quantum of the spectrum in traditional microwave bands for last-mile connectivity purposes. Accordingly, if it is decided that some frequency

spectrum in any one or more of the 6 (lower)/7/13/15/18/21 GHz bands is earmarked for last-mile connectivity i.e. Fixed Wireless Access (FWA), it would become necessary to determine the appropriate spectrum valuation and reserve price for these bands. The methodology and considerations relevant to the valuation of these bands are discussed in detail in subsequent paragraphs.

4.23 In the past[129], for the purposes of spectrum valuation and reserve price determination, the Authority has employed various methodologies such as the Multiple Regression Model, Trend Line Analysis, Production Function Model, Revenue Surplus Model etc. These approaches generally rely on comprehensive datasets containing market and financial parameters such as past auction prices, revenue, spectrum holdings, BTS deployed etc. relevant to the spectrum bands.

4.24 However, if some spectrum in frequency bands viz. 6 GHz (lower)/ 7/ 13/ 15/ 18/ 21 GHz is considered for assignment for last-mile connectivity (Fixed Wireless Access) for commercial telecom services through auction, this would mark the first instance of these bands being auctioned in India. Consequently, the valuation approaches mentioned above cannot be directly applied to these bands owing to the lack of relevant market, financial and technical data. Therefore, it may be necessary to explore alternative methodologies for their valuation.

4.25 It is worth mentioning that in 2022 a similar situation existed while arriving at valuation and reserve price for mid-band (3.3 GHz) and mmWave band (26 GHz), since at that time it marked the first instance of these bands being auctioned in India and no market or financial data relevant to these bands was available. For valuation of these bands, the Authority used alternative approaches such as Technical/ Spectral efficiency approach for mid band and International Benchmarking for mmWave band.

[129] https://www.trai.gov.in/sites/default/files/2024-09/Recommendations_11042022.pdf

4.26 In view of the above, some of the alternative valuation methodologies that may be considered for valuation of 6 GHz (lower)/ 7/ 13/ 15/ 18/ 21 GHz bands include:

(i) Technical/Spectral Efficiency approach

(ii) International Benchmarking

(i) <u>Technical/ Spectral Efficiency approach</u>

4.27 One of the approaches for valuation of microwave bands for last mile connectivity could be based on comparative values that can be achieved by using relative spectral efficiency approach where characteristics like capacity of a particular spectrum band can be compared with the same characteristics of another spectrum band and a spectral efficiency factor can be derived as a ratio.

4.28 The Authority has, in its 2022 recommendation, utilised the spectral efficiency factor for the valuation of spectrum in various band viz. Sub-GHz bands, 2300MHz, 2500MHz, mid-band etc. The Authority in its Recommendations on Auction of Spectrum in frequency bands identified for IMT|5G dated 11.04.2022 utilized the Technical Note (2018) of M/s Nokia on "5G spectrum and Coverage Consideration Aspects" to compare the coverage characteristics of the following various spectrum bands and accordingly derive technical efficiency factor. Based on the cited technical note/report:

- The coverage of the 2300 MHz (and the 2500 MHz) spectrum bands in TDD, is around 50% of the 1800 MHz band FDD coverage. Therefore, a technical efficiency factor of 0.5 was adopted for the spectrum in the 2300 MHz (and the 2500 MHz) band with respect to the spectrum in the 1800 MHz band.
- Mid band (3300-3600 MHz) spectrum band coverage is approximately 30% of the 1800 MHz FDD coverage. Accordingly, a technical efficiency

factor of 0.3 was adopted for the spectrum in the mid-band with respect to the spectrum in the 1800 MHz band.

4.29 As can be seen from the above example, the use of technical efficiency factor by the Authority was backed up by some technical literature/report. However, as of now, no data is publicly available regarding the spectral efficiency factor of the 6(lower)/7/13/15/18/21 GHz relative to other spectrum bands with known auction determined prices (ADPs) from recent 5G auctions. If such spectral efficiency factors were available, they could serve as a basis for valuing microwave bands.

4.30 In this background, the Authority seeks comments from stakeholders on the following set of question(s):

Issues for Consultation:

Q37. In case it is decided to assign some frequency spectrum in 6 (lower)/7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services through auction, then:

i. Should the auction determined price of other bands by using spectral efficiency factor serve as a basis of valuation for the above bands? If yes, which spectrum bands be related, what efficiency factor or formula should be used and what is the basis for the same? Please justify your suggestions.

ii. If response to question (i) above is no, what other methodology may be used. Please justify your suggestions.

(ii) International Benchmarking

4.31 In addition to spectral efficiency factor discussed above, international benchmarking may also serve as an alternative approach to be explored for valuation of these bands. Therefore, there is a need to examine whether internationally available auction-determined prices could serve as a basis for the valuation of the 6 (lower)/7/13/15/18/21 GHz bands spectrum bands for last mile connectivity of commercial telecom services.

4.32 It may be mentioned that when using International Benchmarking, there are cross-country differences in GDP, population, subscriber base etc. This may need to be normalized for use in the context of valuation of spectrum for a particular country.

4.33 The Authority, in its Recommendations on the 'Auction of Spectrum in Frequency Bands Identified for IMT/5G' dated 11.04.2022, considered the ratio of auction prices for 26 GHz and 3.3 GHz bands, across various countries wherein auctions for both these bands were concluded. Taking into account, the ratio of auction prices of 26 GHz and 3.3 GHz of various countries, the Authority arrived at an average ratio of international auction prices between these two bands. This average ratio of international auction prices was then applied to the calculated valuation of 3.3 GHz band (during IMT|5G valuation exercise of 2022) to determine the valuation of 26 GHz band.

4.34 Further, the Authority in its Recommendations on the "Frequency Spectrum in 37-37.5 GHz, 37.5-40 GHz, and 42.5-43.5 GHz bands Identified for IMT" dated 04.02.2025 utilized the ratio of auction price of 37-40GHz and the 24 GHz band in the USA as one of the valuation approaches for valuing the 37-40GHz band in India. Since the ratio was between auction prices of the two bands in the same country, cross-country divergences did not arise, and thereby no normalization was done.

4.35 In this context, it is pertinent to note that Hong Kong is one of the countries that has auctioned spectrum in the 6/7 GHz (6.575 GHz to 7.025 GHz) bands for mobile services. However, given the scope of this Consultation Paper, 6 (lower)/7/13/15/18/21 GHz bands are also being considered for use in Fixed Wireless Access services in India. Therefore, it is necessary to examine whether the ratio of the Auction-Determined Prices of 6/7 GHz band (mobile services) to those of mid-band or mmWave spectrum in Hongkong could serve as a relevant basis for valuing microwave bands in India, particularly if these bands are considered to be deployed for Fixed Wireless Access.

4.36 Details regarding the international auction prices in Hong Kong can be seen in Annexure 4.4, titled "International Experience related to spectrum charging/pricing of Microwave Bands (6, 7, 13, 15, 18, 21 GHz)".

4.37 In this background, the Authority seeks comments from stakeholders on the following set of question(s):

Issues for Consultation:

Q38. In case it is decided to assign some frequency spectrum in 6 (lower)/7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services through auction, then:

i. Should the auction determined price of other countries in 6/7/13/15/18/21 GHz spectrum bands for last mile connectivity and/or IMT services serve as a basis of valuation of microwave bands for last mile connectivity? What methodology should be followed for using this auction determined price as a basis for valuation? Support your suggestions with justifications and country-wise auction data.

ii. **If the above approach is considered appropriate, should the international auction-determined prices be normalized to account for cross-country differences such as population, GDP, purchasing power parity (PPP), subscriber base, and other relevant factors? If so, should normalization be carried out by using the ratio of auction prices of spectrum bands within the same country to neutralize the impact of cross country differences? Alternatively, please suggest any other suitable normalization methodology that may be adopted in this context.**

iii. **Apart from the approaches highlighted above which other valuation approaches may be adopted for the valuation of 6(lower)/7//13/15/18/21 GHz spectrum bands? Please provide detailed information.**

Flexible use for backhaul as well as last-mile connectivity:

4.38 In Chapter II above, the Authority is also examining the issue of assigning spectrum in traditional microwave backhaul bands for a flexible use (backhaul connectivity as well as last-mile connectivity). In case a TSP intends to use the spectrum in traditional microwave backhaul bands for providing the last-mile connectivity (fixed wireless access), which is essentially an Access Service, it will have to acquire such spectrum through auction as per the provisions of Section 4[130] of the Telecommunications Act, 2023.

[130] The relevant extract of Section 4 of the Telecommunications Act, 2023 is reproduced below:
4. (1) The Central Government, being the owner of the spectrum on behalf of the people, shall assign the spectrum in accordance with this Act, and may notify a National Frequency Allocation Plan from time to time.
(2) Any person intending to use spectrum shall require an assignment from the Central Government.
(3) The Central Government may prescribe such terms and conditions as may be applicable, for such assignment of spectrum, including the frequency range, methodology for pricing, price, fees and charges, payment mechanism, duration and procedure for the same.
(4) The Central Government shall assign spectrum for telecommunication through auction except for entries listed in the First Schedule for which assignment shall be done by administrative process.
Explanation.—For the purposes of this sub-section,—
(a) "administrative process" means assignment of spectrum without holding an auction;
(b) "auction" means a bid process for assignment of spectrum.

4.39 In this background, the Authority seeks comments from stakeholders on the following question:

Issues for Consultation:

Q39. What valuation methodology should be followed if it is decided to assign frequency spectrum in traditional microwave backhaul bands for flexible use (i.e. both backhaul connectivity and last mile connectivity) of commercial telecom services through auction? Please provide detailed justification.

E. Spectrum Charges for microwave bands viz. 6 (lower)/7/13/15/18/21 GHz bands for Radio backhaul purposes for non-commercial/ captive backhaul use

4.40 The previous sections, i.e. section I(C) and I(D) of this Chapter dealt with the issues relating to the spectrum charging & valuation of the spectrum in microwave bands viz. 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands for backhaul purposes and for last-mile connectivity (Fixed Wireless Access) of commercial telecom services respectively. The present section deals with Spectrum Charges for microwave bands viz. 6 (lower)/7/13/15/18/21 GHz bands for Radio backhaul purposes for non-commercial/ captive backhaul use.

4.41 DoT through its reference dated 13.09.2024, has informed that *"point to point connectivity requirements of certain captive users is required to be met from one or more of these bands i.e. 6/ 7/ 13/ 15/ 18/ 21 GHz bands. Such requirements are generally localised and mostly limited to few links only. In case, some carriers are specifically earmarked for such use, they can be re-used among multiple users with geographical separation".* Accordingly, recommendations have been sought on quantum/ band(s) of spectrum to be

earmarked for backhaul purposes for non-commercial/ captive use and associated terms & conditions including charges.

4.42 Presently, the spectrum charges are being levied as per DoT's OM no. No. P-11014/34/2009-PP dated 11.12.2023 on the spectrum charges for assignment of frequencies to captive users for different types of radiocommunication services and applications on a provisional basis for the interim period. The detailed order is attached as (Annexure 4.3) and summarized below:

Charging methodology is based on M x C x W formula (M= Basic Royalty, C=No. Freq. Carriers, W=Bandwidth Factor). It will be used for calculation of royalty charges for the Fixed services and Mobile services having multiplexed multi-channels

Annual Royalty Charges (Rs) = M × C × W

Where:

i. M – Factor (Basic Royalty) depends on the maximum operational distance of the network.

Table: M -Factor

Distance Category	Maximum Distance (Km)	Value of M Factor
I	<= 2	750
II	> 2 <= 5	1500
III	> 5 <= 25	3000
IV	> 25 <= 60	6000
V	> 60 <= 120	11000
VI	> 120 <= 500	18750
VII	> 500	25000

ii. W is the bandwidth factor

Table: Bandwidth factor(W)

Slabs of Adjacent Channel Separation (BW), in MHz	Value of W factor
More than 375 kHz and including 2 MHz	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
More than 28 but <= 56	150
More than 56 but <= 112	180
More than 112 but <= 256	210
More than 256 but <= 512	240
> 512	240 + 30 × (Excess bandwidth / 256)

iii. C-factor is the number of frequency carriers

4.43 The existing DoT order determines spectrum charges based on three key factors, including the operational distance of the network (captured by the M-factor), the bandwidth assigned (captured by the W-factor), and the number of frequency carriers allocated (captured by the C-factor). These parameters are necessary for the computation of spectrum charges.

4.44 The 'M' factor in the royalty calculation formula (M × C × W) represents the operational distance between two fixed points in a captive network. As this distance increases, a larger geographic area is occupied by the radio frequency signal, reducing the possibility of spectrum reuse in that region. This extended usage leads to greater consumption of the spectrum resource. Additionally, longer distances often require use of lower frequency bands, which are more valuable due to their superior propagation characteristics. This is similar to fibre networks, where the cost of laying and maintaining fibre increases with

distance. Therefore, an increase in the operational distance directly correlates with higher resource utilisation and opportunity cost, justifying a proportional increase in the M factor for fair and efficient royalty assessment. Similarly, the bandwidth assigned (W-factor) and the number of carriers (C-factor) relate to the capacity of the network to carry information. More bandwidth and additional carriers enable entities to serve more users and transmit more data, which may increase the economic value derived from the spectrum.

4.45 It is open to further examination and discussion- whether additional parameters should be incorporated into the existing formula or modifications could be considered by revising the slabs and/or value of the factors.

4.46 In light of the above, it is necessary to assess whether spectrum charges for the 6 (Lower)/7/13/15/18/21 GHz bands, when used for non-commercial or captive backhaul purposes, should continue to be levied in accordance with the M x C x W formula as specified in the present DoT's order of 2023, or on the basis of a revised formula by inclusion of new determining factors, revision of slab/factor values, or the use of an entirely new spectrum charging methodology.

4.47 In this background, the Authority seeks comments from stakeholders on the following set of questions:

Issues for Consultation:

Q40. Should the spectrum charges for 6 (lower)/ 7/ 13/ 15/ 18/ 21 GHz bands for non-commercial/ captive backhaul use continue to be levied as per the M x C x W formula specified in the DoT's order No. P-11014/34/2009-PP dated 11.12.2023? Is there a need to revise this formula by inclusion of additional factors, modifying slab/factor values etc.? If yes, please specify which additional factors should be included and what should be the revised

slab/factor values? Please provide detail of the same alongwith justification.

Q41. If the answer to above question is no, whether an alternative charging mechanism should be adopted for levying spectrum charges for 6 (lower)/ 7/ 13/ 15/ 18/ 21 GHz bands for non-commercial/ captive backhaul use? Please provide detailed justification.

II. Spectrum charging and valuation of spectrum in E-Band and V-Band

A. Background

4.48 The previous Part (I) of this chapter dealt with the following issues relating to the spectrum charging & valuation of the spectrum in microwave bands viz. 6 GHz (lower)/ 7 GHz/ 13 GHz/ 15 GHz/ 18 GHz and 21 GHz bands:

a) Determination of spectrum charges, if microwave bands are to be used for Backhaul purpose.
b) Valuation and determination of Reserve Price, if microwave bands are assigned for last mile connectivity through auction.
c) Spectrum Charges for microwave bands for Radio backhaul purposes for non-commercial/ captive backhaul use

4.49 This part of the Chapter deals with the following aspects for E-band (71-76 GHz / 81-86 GHz) and V-band (57-64 / 66 GHz):

a) Determination of spectrum charges, if E and/or V bands are to be used for Backhaul purpose.
b) Valuation and determination of Reserve Price, if E and/or V bands are assigned for Access services or Integrated Access Backhaul (IAB) through auction.
c) Spectrum Charges for E-band and V-band for Radio backhaul purposes for non-commercial/ captive backhaul use

4.50 As per GSMA report on "Spectrum for Wireless Backhaul"-

"Over the 5G era, mobile operators will need to continually upgrade their backhaul networks to support growing adoption of the technology and increased usage. Technology upgrades alone will not be able to scale capacity to meet expected demand. This means it will be necessary for regulators to make available additional backhaul bands – especially in higher frequency ranges such as E-band & V-band.

There are a variety of approaches for licensing backhaul bands, especially with the emergence of higher frequency bands and dense small cell networks. Regulators should carefully consider how they can encourage spectrum efficiency and facilitate rapid deployments. Making sure the process can be efficiently managed by all parties is also key. To support the rapid expansion of 5G, it is crucial to have an effective pricing strategy for spectrum in these bands, which are essential for backhaul networks. A well-balanced pricing approach may enable operators to invest in high-speed networks while promoting fair competition and maximizing the efficient use of available spectrum".[131]

B. DoT's reference dated 13.09.2024: Spectrum Charging/Pricing in E-band and V-band

4.51 Regarding the spectrum E-band (71-76 GHz/ 81-86 GHz) and V-band (57-64/66 GHz), DoT through its reference dated 13.09.2024, has requested TRAI to provide recommendations *inter alia*, on the following matters:

(a) Demand assessment and scope of service/usage for (i) 57-64/66 GHz (V-band) and (ii) 71-76 GHz/ 81-86 GHz (E-band) and accordingly methodology of assignment of spectrum and associated terms & conditions, in line with the

[131] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2021/02/wireless-backhaul-spectrum-positions.pdf

determination of scope of services/ usages by TRAI i.e. "Access" or "Backhaul" or "Integrated Access & Backhaul (IAB)".

4.52 Regarding developments related to the E-band and V-band, DoT in the said Reference has stated that:

"The E-Band (71-76 GHz/ 81-86 GHz) has already been assigned LSA-wise for Backhaul purpose to TSPs on provisional basis, during 2022. One of the commercial telecom service providers, holding UL with Access service authorisation, has sought permission for using this band for Access Services, in addition to the Backhaul purposes. i.e. as IAB (Integrated Access & Backhaul). In addition, another service provider, holding UL with Internet service authorisation (ISP) has sought E/V band spectrum for last mile connectivity purposes.

The V-band (57-64/66 GHz) is a part of the band n263 of 3GPP (57 GHz to 71 GHz), which is also referred to as 60 GHz band. That is to say that the complete 57-71 GHz band has been planned by 3GPP as IMT/ Access band. Point to point (backhaul) solutions are also available in the V band. Further, a part of this band, i.e., 66-71 GHz, has already been identified by ITU globally for IMT based Access services in WRC-19."

4.53 Further, as discussed in Chapter III, the Authority is also examining whether it is feasible to allow low power indoor consumer device-to-consumer device usages and low power outdoor usages on a license-exempt basis in the V-band. The Authority is further examining whether the aforementioned license exempt usage should be permitted in V-band in parallel to the use of the spectrum by telecom service providers for backhaul purpose for the establishment of terrestrial networks in a part or full V-band.

4.54 In the light of the above, spectrum charges/price for the V-band may need to be determined in case, after due deliberations and discussions, it is considered that the V-band spectrum will also be used by telecom service providers for

backhaul purpose for the establishment of terrestrial networks, along with license-exempt usage in this band.

C. Spectrum Charges for E-band (71-76 GHz/81-86 GHz) and V-band (57-64/66 GHz) for Backhaul Purpose

TRAI's past Recommendations on E-band and V-band:

4.55 In the year 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. Further, on some of the issues, DoT sought clarifications/ reconsiderations on TRAI's Recommendations through back reference dated 16.10.2015. The Authority gave its response to the DoT's back reference on 17.11.2015. A summary of the same has already been provided in the previous chapters, which may be referred. Recommendations related to spectrum charges for E-band and V-band, made in year 2014, are reproduced below:

- *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 certain factors, 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.*

4.56 However, presently, the spectrum charges for E-band are being levied on a provisional basis in accordance with the 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 Access Spectrum in IMT Bands," dated 25th July 2022.

DoT's present spectrum charging mechanism

4.57 DoT vide its "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 27.07.2022 has prescribed that for each E-band carrier of 250 MHz paired bandwidth, spectrum charges will be levied @ 0.15% of Adjusted Gross Revenue of the TSPs in the interim period, which will be adjusted/recalculated retrospectively (from the date of provisional assignment) based upon the pricing decided finally.

4.58 It is pertinent to note that, at present, spectrum charges for the E-band are levied on a per-carrier/ block basis on provisional basis, calculated as a percentage of the Adjusted Gross Revenue (AGR) of the entire service area. However, in its Recommendations dated 29th August 2014, TRAI had recommended that spectrum charges for the E-band and V-band should be determined on a link-to-link basis.

4.59 In the light of the above, there is a need to examine the prevailing framework and determine whether spectrum charges for E & V bands should be levied on a block basis for the entire Licensed Service Area (LSA) or be revised to a link-to-link basis, as previously recommended by TRAI.

International Spectrum Charging of E & V band

4.60 The international spectrum charges of E-band are examined at Annexure 4.5 – "International Experience related to spectrum charging/pricing of E-Band". With

regard to V-Band, the international experience as already deliberated in Chapter-III is reiterated below:

(a) USA, UK, New Zealand, Australia and Singapore have permitted low-power short-range devices (with specified power limits) on a license-exempt basis in the V-band.

(b) USA, Australia and New Zealand have permitted point-to-point fixed links (with specified power limits) in the V-band on a license-exempt basis without cause harmful interference to licensed users in the band.

(c) UK and Singapore have a licensed regime for wireless systems operating with higher power (EIRP between 40 dBm and 55 dBm) in the V-band. However, details regarding spectrum charges for the same are not available in public domain.

4.61 In this background, the Authority seeks comments of stakeholders on the following set of questions related to E & V bands for backhaul purpose:

Issues for Consultation:

Q42. In case the E-band (71-76/ 81-86 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication services and on a Point-to-Point (P2P) link basis, should the spectrum charges be levied:

i. As a percentage of Adjusted Gross Revenue (AGR), or

ii. On a per carrier/link basis, or

iii. Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per carrier/link charge.

Q43. In case the E-band (71-76/ 81-86 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication

services and on a block basis for the entire Licensed Service Area (LSA), should the spectrum charges be levied:

i. **As a percentage of Adjusted Gross Revenue (AGR), or**
ii. **On a per MHz or per carrier basis, or**
iii. **Through any alternative mechanism (please specify)?**

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per MHz/per carrier charge.

Q44. In case the V-band (57-64/66 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication services and on a Point-to-Point (P2P) link basis, should the spectrum charges be levied:

i. **As a percentage of Adjusted Gross Revenue (AGR), or**
ii. **On a per carrier/link basis, or**
iii. **Through any alternative mechanism (please specify)?**

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per carrier/ link charge.

Q45. In case the V-band (57-64/66 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication services and on a block basis for the entire Licensed Service Area (LSA), should the spectrum charges be levied:

i. **As a percentage of Adjusted Gross Revenue (AGR), or**
ii. **On a per MHz or per carrier basis, or**
iii. **Through any alternative mechanism (please specify)?**

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per MHz/per carrier charge.

D. Valuation of spectrum E-band (71-76 GHz/81-86 GHz) and V-band (57-64/66 GHz) for Access and/or Integrated Access Backhaul.

4.62 The previous Section (C) dealt with the issues relating to the spectrum charging of E-band (71–76/81–86 GHz) and/or V-band (57–64/66 GHz) for backhaul purposes of various commercial telecommunication services while the present section deals with the issues relating to the Valuation of spectrum in E-band (71–76/81–86 GHz) and/or V-band (57–64/66 GHz) for Access (last-mile connectivity) and/or Integrated Access Backhaul.

4.63 It is pertinent to note that the Authority in Chapter-III is examining whether to assign some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access (last mile connectivity)/ Integrated Access Backhaul (IAB) through auction**.** In case E-band (71–76/81–86 GHz) and/or V-band (57–64/66 GHz) are considered to be utilized for Access or Integrated Access Backhaul (IAB), then, it would be necessary to determine the appropriate spectrum valuation and reserve price for these bands. The methodology and key considerations pertaining to the valuation of these bands are discussed in detail in the succeeding paragraphs.

4.64 However, if some frequency spectrum in the E-band (71-76/81-86 GHz) and/or V-band (57-64/66 GHz) is considered for assignment for Access and IAB through auction, this would mark the first instance of these bands being auctioned in India. Consequently, the valuation approaches used for IMT bands such as Multiple Regression Model, Trend Line Analysis, Production Function Model and Revenue Surplus Model cannot be directly applied to these bands owing to the lack of relevant market, financial and technical data related to past auction prices, revenue, spectrum holdings, BTS deployed etc. relevant to the spectrum bands.

4.65 Therefore, it may be necessary to explore alternative methodologies for their valuation.

4.66 As noted earlier in paragraphs 4.26 above, one alternative approach to spectrum valuation is the Technical/Spectral Efficiency Method. This method involves valuing spectrum bands based on their relative spectral efficiency compared to other bands for which auction-determined prices (ADPs) are already available. However, as of now, no publicly available data exists regarding the spectral efficiency factor of the E-band (71–76/81–86 GHz) and V-band (57–64/66 GHz) relative to other spectrum bands with known ADPs from recent 5G auctions. If such spectral efficiency factors were available, they could serve as a basis for valuing the E and V bands.

4.67 In this background, the Authority invites comments from stakeholders on the following set of question(s):

Issues for Consultation:

Q46. In case it is decided to assign some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access (last mile connectivity)/ Integrated Access Backhaul (IAB) through auction, then:

(i) Should the auction determined price of other bands serve as a basis of valuation for the above bands using spectral efficiency factor? If yes, which spectrum bands be related, what efficiency factor or formula should be used and what should be the basis for the same? Please justify your suggestions.

(ii) If response to question (i) above is no, what other methodology may be used? Please justify your suggestions.

4.68 In addition to spectral efficiency factor discussed above, international benchmarking may also serve as an alternative approach to be explored for valuation of E-band (71–76/81–86 GHz) and V-band (57–64/66 GHz).

4.69 It may be noted that international spectrum charges for the E-band, assigned administratively, for backhaul use, have been attached as Annexure-4.5. Further with regard to international experience on V-band, paragraph 4.59 highlights that many countries have permitted low-power short-range devices to operate on a license-exempt basis. Meanwhile, the UK and Singapore follow a licensed regime for higher-power wireless systems although, information on the applicable spectrum charges is not publicly available.

4.70 However, in the current context, if it is decided to assign spectrum in the E-band and/or V-band for Access(last mile connectivity) or Integrated Access Backhaul (IAB) through auction, the existing international administrative charges for backhaul use cannot be used as a basis for valuation due to the difference in intended use (Access/IAB vs. backhaul) and assignment methodology (auction vs. administrative allocation). That said, if international auction determined prices specific to E and V band for Access or IAB use were available, they could potentially serve as a basis for the valuation of E-band and V-band spectrum for such purposes

4.71 In this background, the Authority seeks comments of stakeholders on the following set of question(s):

Issues for Consultation:

Q47. In case it is decided to assign some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access (last mile connectivity)/ Integrated Access Backhaul (IAB) through auction, then:

i. Should the auction determined price of other countries in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) serve as a basis of valuation of these bands? If yes, what methodology should be followed for using this auction determined price as a basis for valuation? Support

your suggestions with justifications and country-wise auction data.

ii. **If the above approach is considered appropriate, should the international auction-determined prices be normalized to account for cross-country differences such as population, GDP, purchasing power parity (PPP), subscriber base, and other relevant factors? If so, should normalization be carried out by using the ratio of auction prices of spectrum bands within the same country to neutralize the impact of cross country differences? Alternatively, please suggest any other suitable normalization methodology that may be adopted in this context.**

iii. **Apart from the approaches highlighted above which other valuation approaches should be adopted for the valuation of E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz)? Please provide detailed information.**

E. Spectrum Charges for E-band (71-76 GHz/81-86 GHz) and V-band (57-64/66 GHz) for Radio backhaul purposes for non-commercial/ captive backhaul use

4.72 The previous sections i.e. section (C) & section (D) dealt with the issues relating to the spectrum charging & valuation of the spectrum in E-band (71-76 GHz/81-86 GHz) and V-band (57-64/66 GHz) for backhaul purposes and for Access (last-mile connectivity) and/or IAB respectively. While the present section deals with Spectrum Charges for E-band (71-76 GHz/81-86 GHz) and V-band (57-64/66 GHz) for Radio backhaul purposes for non-commercial/ captive backhaul use.

4.73 In Chapter III of this Consultation Paper, the Authority is examining the aspect of whether there exists a requirement to earmark a certain quantum of

spectrum in the E-band and V-band specifically for point-to-point connectivity needs of captive (non-commercial/ non-TSP) users. In the event such a requirement is established, the Authority is further deliberating on the appropriate quantum of spectrum that should be reserved in each of these bands for such use cases as well as the suitable terms and conditions that should govern such spectrum assignments.

4.74 It would be necessary to determine the appropriate spectrum charges, in case after due analysis/deliberations it is considered that some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) should be earmarked for point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users.

4.75 It may be noted that presently, E band and V-band have not been assigned for captive use. In case they are assigned for such a use, one approach may be to determine spectrum charges based on M x C x W formula (M= Basic Royalty, C=No. Freq. Carriers, W=Bandwidth Factor) as discussed in para 4.42.

4.76 Further as stated in para 4.45, this formula is open to further examination and discussion- whether additional parameters should be incorporated into the existing formula or modifications could be considered by revising the slabs and/or value of the factors.

4.77 Another approach can be to levy fixed fee spectrum charges for E-band and V -band carriers on a link to link basis as recommended by TRAI in its 2014 recommendations. The Authority in 2014, based on the study of international trends, the usefulness of the bands in accelerating the growth of mobile data segment, and overall growth in ICT and in view of the fact that it is almost a greenfield area for short distance backhaul, reached the conclusion that the price of carriers in E-band and V-band should be kept low so as to leverage technology. It may be noted that the factors considered by the Authority for

determining spectrum charges for E-band and V- band in 2014 are relevant even in the present context.

4.78 In light of the above, it is necessary to assess whether spectrum charges for E band and V band, when used for non-commercial or captive backhaul purposes, should be levied in accordance with :

- Spectrum charges recommended by TRAI in 2014, or
- M x C x W formula, Or
- An alternative charging mechanism by inclusion of new determining factors, revision of slab/factor values of the above formula or the use of an entirely new spectrum charging methodology.

4.79 In this background, the Authority seeks comments of stakeholders on the following set of question(s):

Issues for Consultation:

Q48. In case it is decided to assign some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users, then:

(i) Should the spectrum charges for E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users may be levied as per the M x C x W formula as specified in the DoT's order No. P-11014/34/2009-PP dated 11.12.2023? Is there a need to revise this formula by inclusion of additional factors, modifying slab/factor values etc.? If yes, please specify which additional factors should be included and what

should be the revised slab/factor values. Please provide detail of the same along with justification.

(ii) If the answer to above question is no, whether an alternative charging mechanism such as link to link charges as recommended in 2014 for levying spectrum charges for E and V bands for non - commercial/ captive backhaul use, should be adopted? Please provide detailed justification.

III. Single vs. Multiple Approaches

4.80 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 several such approaches to arrive at a final reasonable valuation and then determine reserve price based on such valuation.

4.81 This approach is justified since the attempt is to arrive at the 'Expected Value' of the valuation of spectrum from the set of available valuations, and the simple mean serves this purpose as a measure of central location.

4.82 The Authority has been using various approaches to arrive at the valuation of different spectrum bands and to determine the reserve price of different spectrum bands for the auction of various bands of spectrum from time to time.

4.83 The Authority has been of the view that it is not possible to say deterministically that any one methodology/ approach is the right method for determining the value of spectrum in various bands. Each method/ approach/ model has certain strengths as well as limitations. Some models capture intrinsic technical features better, whereas others are based on economic and market realities. No particular model completely captures every variable related to technical, economic, sectoral, geographic and regulatory realms that influence the

valuation of spectrum. Accordingly, it would be appropriate to rely on several such approaches to arrive at a final reasonable valuation rather than depending on the valuation arrived at using only one approach.

4.84 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.

4.85 In this background, the Authority seeks comments of stakeholders on the following set of questions:

Issues for consultation:

Q49. In case it is decided to assign some frequency spectrum in 6 (lower)/ 7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services and in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access (last mile connectivity)/ Integrated Access Backhaul(IAB) through auction, then:
Should the value of:
(a) 6 (lower)/7/13/15/18/21 GHz bands (for last mile connectivity)
(b) E-band (71–76/81–86 GHz) and V-band (57–64/66 GHz) (for Access (last mile connectivity)/IAB)
be determined using a single valuation approach? If yes, please indicate which single valuation approach or method should be adopted in each case and provide detailed justification

Q50. 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 the above spectrum bands, or some other approach like taking weighted mean etc. should be followed? Please support your answer with detailed justification.

IV. Reserve Price estimation

4.86 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 a very low level is inefficient in deterring collusion and if set at a very high level can negatively impact participation in the auction. Thus, to ensure efficiency of the auction process, setting the reserve price at an optimal level is a prerequisite.

4.87 Thus, a balanced intermediate reserve price satisfies the basic objectives of reserve price setting viz., ensuring realization of the underlying value of the asset being auctioned and deterring collusive behaviour among bidders. In order to ensure competitive bidding and price discovery, the reserve price should not be too close to the expected/predicted valuation of the object put up for auction**.**

4.88 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 derived from all possible approaches. The Authority was of the view that reserve price set at the level of 70% of average valuation in view of the context of the forthcoming auction, will ensure healthy competition, leading to the discovery of the true market price.

4.89 While framing the said recommendation, the Authority also took into account following considerations:

- It referred to various economic and market-related studies which indicated that, in many instances, regulators adopt a practice of setting reserve prices at 70% to 80% of estimated spectrum value. Some of these were highlighted, as follows:
    - Brown and Morgan[132] found from results of field experiments of auctions of collectible coins that positive reserve prices set at the level of 70% of the purchase price of the coins lead to higher revenues and lower number of bidders relative to zero reserve prices
    - Malisuwan[133] et al noted that the ratio of reserve price to auction price "…possibly varies greatly across the historical database -from less than 0.1 to 1", and that in many cases, regulators determine to multiply estimates of spectrum value by 70%-80% to derive the reserve prices
    - The Authority also noted that Plum Consulting, as part of the ITU team advising the National Broadcasting and Telecommunications Commission (Thailand) ahead of the 2015 auctions in the 900 MHz and 1800 MHz bands, had recommended reserve prices at approximately 70% of the estimated value.[134]
    - Furthermore, the Authority reviewed bidding activity in previous auctions, including the number of bidders, the quantum of spectrum put to and sold through auction, and comparisons between Auction Determined Prices and reserve prices.

4.90 On this basis, the Authority considered that a reserve price set at 70% of the average valuation of spectrum band would go a long way in helping discover the market clearing price of the spectrum

[132] Brown, Jennifer and John Morgan (2009), How much is a Dollar Worth? Tipping versus equilibrium co-existence on competing online auction sites, The Journal of Political Economy

[133] Malisuwan, Settapong, et al (2016), Mobile Spectrum Value and Reserve Price by using Benchmarking Approaches, International Journal of Scientific Engineering and Technology, 5:1 (pp. 81-4)

[134] Chan, Yi Shen and Sarongrat Wongsaroj (2016), Valuing Spectrum in Thailand: what can we learn?, Plum Insight, available at plumconsulting.co.uk.

4.91 In this background, the Authority seeks comments from stakeholders on the following set of questions:

Issues for consultation

Q51. In case it is decided to assign some frequency spectrum in 6 (lower)/ 7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services and in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access(last mile connectivity)/ Integrated Access Backhaul (IAB) through auction, then:

What ratio should be adopted between the reserve price for the auction and the valuation of the spectrum in:

(a) 6 (lower)/7/13/15/18/21 GHz bands (for last mile connectivity)

(b) E-band (71–76/81–86 GHz) and V-band (57–64/66 GHz) (for Access (last mile connectivity)/IAB)

and why? Please support your answer with detailed justification.

V. Payment Terms

4.92 Payment terms and associated conditions need to be determined if it is decided to assign some frequency spectrum in 6 (lower)/ 7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services and in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access(last mile connectivity)/ Integrated Access Backhaul (IAB) through auction.

4.93 It is important to note that various aspects of the payment terms—such as the total number of instalments, the applicable interest rate for preserving the net present value (NPV), upfront payment, and related elements—are linked to the

validity period. The issues pertaining to the validity period for assignment of spectrum through auction, have been discussed in detail in Chapter-II and Chapter-III. This section of this chapter addresses key aspects of the payment terms, including the upfront payment, moratorium period, total number of instalments for deferred payment recovery, and the interest rate applicable to safeguard the NPV of the bid amount.

4.94 In this context, a reference can be drawn from the payment terms prescribed under Notice Inviting Applications (NIA) for auction of spectrum in 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300 MHz, and 26 GHz Bands dated 08.03.2024 for validity of 20 years:

i. Successful Bidders shall make the payment (in Indian Rupees) in accordance with any of the following two options:

Option 1: Full or part upfront payment of the bid amount within 10 days of declaration of final price. Where part upfront payment has been made, which can be a multiple of complete years with a minimum of two years, the buyer shall have the option of availing moratorium for the corresponding number of years for which the upfront payment has been made and the balance amount shall be payable in equal annual instalments over the remaining period, payable in advance at the beginning of each year, after the period of moratorium if any, duly protecting the Net Present Value (NPV) of the bid amount at the applicable rate of interest.

Option 2: Payment of 20 equal annual instalments of the bid amount, duly protecting the NPV of the bid amount at the applicable rate of interest, in advance at the beginning of the year, the first instalment becoming payable within 10 days of declaration of final price. The balance 19 instalments shall become due and payable on the Effective Date anniversary of each following year…..

ii Prepayment option: - Pre-payment of one or more instalments has been allowed on any date, provided that the NPV of the due amount is protected at the applicable interest rate.

iii Number of instalments: For the case of deferred payments, the balance amount is to be paid in equal annual instalments over the remaining period, payable in advance at the beginning of each year, after the period of moratorium if any, duly protecting the Net Present Value (NPV) of the bid amount at the applicable rate of interest.

iv. The NPV of the bid amount was protected at applicable rate of interest. In this regard, the following questions arise for consultation: -

4.95 In this background, the Authority seeks comments from stakeholders on the following set of questions:

4.96 **Issues for consultation:**

Q52. In case it is decided to assign some frequency spectrum in 6 (lower)/ 7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services and in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access(last mile connectivity)/ Integrated Access Backhaul (IAB) through auction, then: What should the payment terms and associated conditions for the assignment of

(a) 6 (lower)/7/13/15/18/21 GHz bands (for last mile connectivity)

(b) E-band (71–76/81–86 GHz) and V-band (57–64/66 GHz) (for Access (last mile connectivity)/IAB)

relating to:

i. Upfront payment

ii. Moratorium period

iii. Total number of instalments to recover deferred payment

iv. **Applicable interest rate for protecting the NPV of bid amount Please support your answer with detailed justification.**

Q53. Any other suggestions relevant to the subject may be submitted with detailed justification.

4.97 The following chapter provides a list of issues for consultation.

Chapter V: Issues for Consultation

Stakeholders are requested to provide responses to the following questions with detailed justification.

Q1. What is the level of demand of the spectrum in the traditional microwave backhaul bands [viz. 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands] for radio backhaul purposes? Kindly provide a detailed response with justifications.

Q2. For which commercial telecommunication services should the spectrum in traditional microwave backhaul bands be assigned for radio backhaul purposes? Kindly provide a detailed response with justifications.

Q3. Which of the following methods should be used for the assignment of the spectrum in traditional microwave backhaul bands for radio backhaul purposes for various commercial telecommunication services:

(a) Block-basis in LSA,

(b) Point-to-point link-basis, or

(c) Any other?

Please provide a detailed response with justifications in respect of the relevant commercial telecommunication services.

Q4. In case it is decided to use different methods (block-based, link-based, or any other) for the assignment of the spectrum in traditional microwave backhaul bands for radio backhaul purposes for different types of commercial telecommunication services, what quantum of spectrum, and in which of 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands should be earmarked for point-

to-point link-based assignments? Kindly provide a detailed response with justifications.

Q5. What should be the terms and conditions for the assignment of spectrum in traditional microwave backhaul bands for radio backhaul purposes of various commercial telecommunication services, such as -

(a) Carrier size;

(b) Carrier aggregation;

(c) Validity period of the assignment;

(d) Renewal mechanism;

(e) Roll-out obligations; and

(f) Surrender of spectrum etc.?

Kindly provide a detailed response with justifications. along with the international scenario on the matter.

Q6. Is there a need to prescribe ceilings on the number of carriers that can be assigned to a commercial telecommunication service provider in each frequency band [6 GHz (lower)/ 7 GHz/ 13 GHz/ 15 GHz/ 18 GHz/ 21 GHz] or in a group of frequency bands for radio backhaul purposes? Kindly provide a detailed response with justifications.

Q7. In case it is decided to prescribe ceilings on the number of carriers that can be assigned to a commercial telecommunication service provider (TSP) for each frequency band or each group of frequency bands, -

(a) Should there be any criterion for the ceiling on the number of carriers that may be assigned to a TSP? If yes, what should be the criteria?

(b) In case of group of frequency bands, how should the bands be grouped?

(c) What should be the respective ceilings for each frequency band, or each group of frequency band(s)?

(d) Should there be any provision for assignment of spectrum above the ceiling limit on a case-by-case basis? If yes, what criterion should be prescribed, based on which, additional spectrum above the ceiling limit may be assigned to a telecom service provider?

Kindly provide a detailed response with justifications.

Q8. In the new policy regime for the assignment of spectrum, whether there is a need to grant an option to telecom service providers already holding carriers in traditional microwave backhaul bands to retain the existing carriers with them? Kindly provide a detailed response with justifications.

Q9. As the 7125-8400 MHz range in the 7 GHz band and the 14.8-15.35 GHz range in the 15 GHz band are being considered for IMT in WRC-27, whether there is a need to review the usage of 7 GHz and 15 GHz microwave backhaul bands at this stage itself, or should the review be undertaken after considering the outcome of WRC-27? Kindly provide a detailed response with justifications.

Q10. In case it is decided to review the usage of 7 GHz and 15 GHz bands at this stage itself, what should be the policy framework for the assignment of the spectrum in 7 GHz and 15 GHz microwave backhaul bands to take care the possible outcomes of AI 1.7 of the WRC-27? Kindly provide a detailed response with justifications.

Q11. Whether there is a need to earmark certain quantum of spectrum in traditional microwave backhaul bands for the last-mile connectivity (Fixed Wireless Access) to the customer equipment of commercial

telecommunication services? Please provide a detailed response with justifications.

Q12. In case it is decided to earmark certain quantum of spectrum in traditional microwave backhaul bands for the last-mile connectivity (Fixed Wireless Access) to the customer equipment of commercial telecommunication services, -

(a) What quantum of spectrum, and in which of 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands should be earmarked for such purposes?

(b) What should be the eligibility conditions to obtain the spectrum in traditional microwave backhaul bands for such purposes?

(c) What should be the terms and conditions for the assignment of spectrum in traditional microwave backhaul bands for such purposes through auction such as-

(i) Block size;

(ii) Minimum quantity for bidding;

(iii) Spectrum cap;

(iv) Validity period of the assignment;

(v) Roll-out obligations;

(vi) Surrender of spectrum etc.?

(d) Whether flexible use i.e., both backhaul connectivity, and last mile connectivity (fixed wireless access) to the customer equipment should be permitted in the frequency ranges earmarked for such purposes? If yes, should the terms and conditions of the auction of spectrum be the same as those applicable for the "access spectrum"?

Kindly provide a detailed response with justification and international practice.

Q13. Should a certain quantum of the spectrum in traditional microwave backhaul bands be earmarked for fulfilling point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users? If yes -

(a) What quantum of spectrum, and in which of 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands should be earmarked for such purposes?

(b) What should be the terms and conditions for the assignment of spectrum for such purposes, such as-

(i) Carrier size;

(ii) Carrier aggregation;

(iii) Ceiling on the number of carriers;

(iv) Validity period of the assignment;

(v) Renewal mechanism;

(vi) Criteria for the assignment of additional spectrum above the ceiling limit;

(vii) Roll out obligations; and

(viii) Surrender of the spectrum, etc.?

Kindly provide a detailed response with justifications.

Q14. In case your response to Q13 is 'no', in what manner should the point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users be fulfilled? Kindly provide a detailed response with justifications.

Q15. In case it is decided to assign the spectrum in traditional microwave backhaul bands on a point-to-point link basis to cater to point-to-point connectivity requirements of commercial telecommunication service providers as well as captive (non-commercial/ Non-TSP) users, whether there is a need to prescribe minimum link lengths (path lengths) in these bands? If yes, what should be the minimum

link length for each of the traditional microwave backhaul bands? Kindly provide a detailed response with justifications.

Q16. Considering that the Government has decided to delicense the 6 GHz (lower) band (5.925-6.425 GHz) for low power applications, whether there is any need to prescribe certain measures to provide necessary protection to incumbent users such as Fixed Microwave (backhaul) Services, Fixed Satellite Service (FSS) etc. operating in the 6 GHz (lower) band? If yes, which specific measures should be prescribed for this purpose? Kindly provide a detailed response with justifications.

Q17. Any other suggestions relevant to the assignment of spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands may kindly be provided with detailed justifications.

Q18. What is the level of demand of the spectrum in the E-band (71-76 GHz, and 81-86 GHz) for each of the service/ usage viz. "Backhaul", "Access" and "Integrated Access & Backhaul (IAB)"? Kindly provide a detailed response in respect of each service/ usage with justification including availability of technical standards and eco-system.

Q19. What is the level of demand of the spectrum in the V-band (57-64/ 66 GHz) for each of the service/ usage viz. Backhaul, Access and IAB? Kindly provide a detailed response in respect of each service/ usage with justification including availability of technical standards and eco-system.

Q20. For which commercial telecommunication services should the spectrum in E-band and V-band be assigned for radio backhaul

purposes? Responses with detailed justifications may kindly be provided for E-band and V-band separately.

Q21. Which of the following methods should be used for the assignment of the spectrum in E-band and V-band for radio backhaul purposes for various commercial telecommunication services:

(a) Block-basis in LSA;

(b) Point-to-point link-basis; or

(c) Any other?

Responses with detailed justifications may kindly be provided for E-band and V-band separately in respect of the relevant commercial telecommunication services.

Q22. In case it is decided to use different methods (block-based, link-based, or any other) for the assignment of the spectrum in E-band and/ or V-band for radio backhaul purposes for different types of commercial telecommunication services, how much spectrum in E-band and V-band should be earmarked for the point-to-point link-based assignment for radio backhaul purposes for commercial telecommunication services? Responses with justifications may kindly be provided for E-band and V-band separately.

Q23. What should be the terms and conditions for the assignment of the spectrum in the E-band for radio backhaul purposes of commercial telecom services such as-

(i) Band plan;

(ii) Carrier size;

(iii) Carrier aggregation;

(iv) Validity period of the assignment;

(v) Renewal mechanism;

(vi) Surrender of the spectrum;

(vii) Ceiling on the number of carriers (spectrum cap);

(viii) Criteria for the assignment of additional spectrum above the ceiling limit; and

(ix) Roll-out obligations etc.?

Kindly provide a detailed response with justifications.

Q24. What frequency range (57-64 GHz, or 57-66 GHz) in the V-band should be adopted for radio backhaul purposes? In case you are of the opinion that the 57-66 GHz range should be adopted for radio backhaul purposes, considering that the 66-71 GHz range is already identified for IMT, whether there is a need for provisioning a guard band between the 57-66 GHz range (for the backhaul purposes) and the 66-71 GHz range (for IMT)? If yes, what should be the guard band? Kindly provide a detailed response with justifications.

Q25. What should be the terms and conditions for the assignment of the spectrum in the V-band for radio backhaul purposes of commercial telecom services including the following aspects:

(i) Band plan;

(ii) Carrier size;

(iii) Carrier aggregation;

(iv) Validity period of the assignment;

(v) Renewal mechanism;

(vi) Surrender of the spectrum;

(vii) Ceiling on the number of carriers (spectrum cap);

(viii) Criteria for the assignment of additional spectrum above the ceiling limit; and

(ix) Roll-out obligations etc.?

Kindly provide a detailed response with justifications

Q26. In case it is decided to earmark a few carriers in E-band and/ or V-band for services/ usages as "Access" and/ or "Integrated Access & Backhaul (IAB)", -

(a) What quantum of spectrum in E-band and V-band should be earmarked for such services/ usages?

(b) What should be the eligibility conditions to obtain the spectrum in E-band and V-band for such services/ usages?

(c) What should be the terms and conditions for the assignment of spectrum in E-band and V-band through auction such as-

(i) Block size;

(ii) Minimum quantity for bidding;

(iii) Spectrum cap;

(iv) Validity period of the assignment;

(v) Roll-out obligations; and

(vi) Surrender of spectrum etc.?

(d) Should flexible use [i.e., radio backhaul, and last mile connectivity (fixed wireless access) to the customer equipment] be permitted in frequency ranges earmarked in E-band and/ or V-band for such services/ usages? If yes, should the terms and conditions of the auction of spectrum be the same as those applicable for "access spectrum"?

Responses with detailed justifications and international practices may kindly be provided for E-band and V-band separately.

Q27. Whether there is a need for earmarking certain quantum of spectrum in E-band and V-band for point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users? If yes,-

(a) What quantum of spectrum in E-band and V-band should be earmarked for such purposes?

(b) What should be the terms and conditions for the assignment of spectrum such as:

(i) Carrier size;

(ii) Carrier aggregation;

(iii) Ceiling on the number of carriers;

(iv) Validity period of the assignment;

(v) **Renewal mechanism;**

(vi) **Criteria for the assignment of additional spectrum above the ceiling limit;**

(vii) **Roll out obligations; and**

(viii) **Surrender of the spectrum etc.?**

Responses with detailed justifications may kindly be provided for E-band and V-band separately.

Q28. In case your response to Q27 is 'no', in what manner should the point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users be fulfilled? Kindly provide a detailed response with justifications.

Q29. Whether it is feasible to allow low power indoor consumer device-to-consumer device usages on a license-exempt basis in the V-band in parallel to the use of the spectrum by telecom service providers for the establishment of terrestrial networks in a part or full V-band? Kindly provide a detailed response with justification and international scenario.

Q30. In case it is decided to allow low power indoor consumer device-to-device usages on a license-exempt basis in the V-band (57-64/66 GHz), -

(a) Should it be permitted in the entire V-band or only in a portion of the V-band? If it should be permitted only in a portion of the V-band, please specify the frequency range.

(b) In case it is decided to permit low power indoor consumer device-to-device usages on a license-exempt basis in the entire V-band, whether the 57-64 GHz range, or the 57-66 GHz range should be considered for such usages?

(c) What should be the carrier size/ channel bandwidth?

(d) What should be the definition of indoor usages?

(e) **What technical parameters should be prescribed, including EIRP limits for low power indoor consumer device-to-device usages?**

Kindly provide a detailed response with justifications and international scenario.

Q31. Whether there is a need for permitting "outdoor" usages of V-band on a license-exempt basis? Kindly provide a detailed response with justification and international scenario.

Q32. If the response to the Q31 is in the affirmative, whether it is feasible to allow outdoor usages on a license-exempt basis in the V-band in parallel to the use of the spectrum by telecom service providers for the establishment of terrestrial networks in a part or full V-band? Kindly provide a detailed response with justification and international scenario.

Q33. In case it is decided to allow outdoor usages on a license-exempt basis in the V-band (57-64/ 66 GHz), -

(a) **Should it be permitted in the entire V-band or only in a portion of the V-band? If it should be permitted only in a portion of the V-band, please specify the frequency range.**

(b) **In case it is decided to permit outdoor usages on a license-exempt basis in the entire V-band, whether the 57-64 GHz range, or the 57-66 GHz range should be considered for such usages?**

(c) **What should be the carrier size/ channel bandwidth?**

(d) **What technical parameters should be prescribed, including EIRP limits for low power indoor consumer device-to-device usages?**

Kindly provide a detailed response with justifications and international scenario.

Q34. Any other suggestions relevant to the assignment of the spectrum in E-band (71-76/ 81-86 GHz) and V-band (57-64/ 66 GHz) may kindly be made with detailed justifications.

Q35. In case the 6 (lower)/7/13/15/18/21 GHz bands for radio backhaul of various commercial telecom services are assigned on a Point-to-Point (P2P) Link basis, should the spectrum charges be levied:

i. As a percentage of Adjusted Gross Revenue (AGR), or

ii. On a per carrier/link basis, or

iii. Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per link/per carrier charge.

Q36. In case the 6 (lower)/7/13/15/18/21 GHz bands for radio backhaul of various commercial telecom services are assigned on a block basis for the entire Licensed Service Area (LSA), should the spectrum charges be levied:

i. As a percentage of Adjusted Gross Revenue (AGR), or

ii. On a per MHz or per carrier basis, or

iii. Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per carrier/ MHz charge.

Q37. In case it is decided to assign some frequency spectrum in 6 (lower)/7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services through auction, then:

i. Should the auction determined price of other bands by using spectral efficiency factor serve as a basis of valuation for the above bands? If yes, which spectrum bands be related, what

efficiency factor or formula should be used and what is the basis for the same? Please justify your suggestions.

ii. If response to question (i) above is no, what other methodology may be used. Please justify your suggestions.

Q38. In case it is decided to assign some frequency spectrum in 6 (lower)/7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services through auction, then:

i. Should the auction determined price of other countries in 6/7/13/15/18/21 GHz spectrum bands for last mile connectivity and/or IMT services serve as a basis of valuation of microwave bands for last mile connectivity? What methodology should be followed for using this auction determined price as a basis for valuation? Support your suggestions with justifications and country-wise auction data.

ii. If the above approach is considered appropriate, should the international auction-determined prices be normalized to account for cross-country differences such as population, GDP, purchasing power parity (PPP), subscriber base, and other relevant factors? If so, should normalization be carried out by using the ratio of auction prices of spectrum bands within the same country to neutralize the impact of cross country differences? Alternatively, please suggest any other suitable normalization methodology that may be adopted in this context.

iii. Apart from the approaches highlighted above which other valuation approaches may be adopted for the valuation of 6(lower)/7//13/15/18/21 GHz spectrum bands? Please provide detailed information.

Q39. What valuation methodology should be followed if it is decided to assign frequency spectrum in traditional microwave backhaul bands

for flexible use (i.e. both backhaul connectivity and last mile connectivity) of commercial telecom services through auction? Please provide detailed justification.

Q40. Should the spectrum charges for 6 (lower)/ 7/ 13/ 15/ 18/ 21 GHz bands for non-commercial/ captive backhaul use continue to be levied as per the M x C x W formula specified in the DoT's order No. P-11014/34/2009-PP dated 11.12.2023? Is there a need to revise this formula by inclusion of additional factors, modifying slab/factor values etc.? If yes, please specify which additional factors should be included and what should be the revised slab/factor values? Please provide detail of the same alongwith justification.

Q41. If the answer to above question is no, whether an alternative charging mechanism should be adopted for levying spectrum charges for 6 (lower)/ 7/ 13/ 15/ 18/ 21 GHz bands for non-commercial/ captive backhaul use? Please provide detailed justification.

Q42. In case the E-band (71-76/ 81-86 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication services and on a Point-to-Point (P2P) link basis, should the spectrum charges be levied:

i. As a percentage of Adjusted Gross Revenue (AGR), or

ii. On a per carrier/link basis, or

iii. Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per carrier/link charge.

Q43. In case the E-band (71-76/ 81-86 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication

services and on a block basis for the entire Licensed Service Area (LSA), should the spectrum charges be levied:

i. **As a percentage of Adjusted Gross Revenue (AGR), or**
ii. **On a per MHz or per carrier basis, or**
iii. **Through any alternative mechanism (please specify)?**

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per MHz/per carrier charge.

Q44. In case the V-band (57-64/66 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication services and on a Point-to-Point (P2P) link basis, should the spectrum charges be levied:

i. **As a percentage of Adjusted Gross Revenue (AGR), or**
ii. **On a per carrier/link basis, or**
iii. **Through any alternative mechanism (please specify)?**

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per carrier/ link charge.

Q45. In case the V-band (57-64/66 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication services and on a block basis for the entire Licensed Service Area (LSA), should the spectrum charges be levied:

i. **As a percentage of Adjusted Gross Revenue (AGR), or**
ii. **On a per MHz or per carrier basis, or**
iii. **Through any alternative mechanism (please specify)?**

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per MHz/per carrier charge.

Q46. In case it is decided to assign some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access (last mile connectivity)/ Integrated Access Backhaul (IAB) through auction, then:

(i) Should the auction determined price of other bands serve as a basis of valuation for the above bands using spectral efficiency factor? If yes, which spectrum bands be related, what efficiency factor or formula should be used and what should be the basis for the same? Please justify your suggestions

(ii) If response to question (i) above is no, what other methodology may be used? Please justify your suggestions.

Q47. In case it is decided to assign some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access (last mile connectivity)/ Integrated Access Backhaul (IAB) through auction, then:

i. Should the auction determined price of other countries in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) serve as a basis of valuation of these bands? If yes, what methodology should be followed for using this auction determined price as a basis for valuation? Support your suggestions with justifications and country-wise auction data.

ii. If the above approach is considered appropriate, should the international auction-determined prices be normalized to account for cross-country differences such as population, GDP, purchasing power parity (PPP), subscriber base, and other relevant factors? If so, should normalization be carried out by using the ratio of auction prices of spectrum bands within the same country to neutralize the impact of cross country differences? Alternatively, please suggest any other suitable normalization methodology that may be adopted in this context.

iii. **Apart from the approaches highlighted above which other valuation approaches should be adopted for the valuation of E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz)? Please provide detailed information.**

Q48. In case it is decided to assign some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users, then:

(i) Should the spectrum charges for E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users may be levied as per the M x C x W formula as specified in the DoT's order No. P-11014/34/2009-PP dated 11.12.2023? Is there a need to revise this formula by inclusion of additional factors, modifying slab/factor values etc.? If yes, please specify which additional factors should be included and what should be the revised slab/factor values. Please provide detail of the same along with justification.

(ii) If the answer to above question is no, whether an alternative charging mechanism such as link to link charges as recommended in 2014 for levying spectrum charges for E and V bands for non - commercial/ captive backhaul use, should be adopted? Please provide detailed justification.

Q49. In case it is decided to assign some frequency spectrum in 6 (lower)/ 7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services and in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access (last mile connectivity)/ Integrated Access Backhaul(IAB) through auction, then:

Should the value of:

(a) 6 (lower)/7/13/15/18/21 GHz bands (for last mile connectivity)

(b) E-band (71–76/81–86 GHz) and V-band (57–64/66 GHz) (for Access (last mile connectivity)/IAB)

be determined using a single valuation approach? If yes, please indicate which single valuation approach or method should be adopted in each case and provide detailed justification

Q50. 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 the above spectrum bands, or some other approach like taking weighted mean etc. should be followed? Please support your answer with detailed justification.

Q51. In case it is decided to assign some frequency spectrum in 6 (lower)/ 7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services and in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access(last mile connectivity)/ Integrated Access Backhaul (IAB) through auction, then:

What ratio should be adopted between the reserve price for the auction and the valuation of the spectrum in:

(a) 6 (lower)/7/13/15/18/21 GHz bands (for last mile connectivity)

(b) E-band (71–76/81–86 GHz) and V-band (57–64/66 GHz) (for Access (last mile connectivity)/IAB)

and why? Please support your answer with detailed justification.

Q52. In case it is decided to assign some frequency spectrum in 6 (lower)/ 7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services and in E-

band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access(last mile connectivity)/ Integrated Access Backhaul (IAB) through auction, then:

What should the payment terms and associated conditions for the assignment of

(a) 6 (lower)/7/13/15/18/21 GHz bands (for last mile connectivity)

(b) E-band (71–76/81–86 GHz) and V-band (57–64/66 GHz) (for Access (last mile connectivity)/IAB)

relating to:

i. Upfront payment

ii. Moratorium period

iii. Total number of instalments to recover deferred payment

iv. Applicable interest rate for protecting the NPV of bid amount Please support your answer with detailed justification.

Q53. Any other suggestions relevant to the subject may be submitted with detailed justification.

Annexures

Annexure 1.1: DoT's Reference 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.

Page 1 of 2

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 1.2: DoT's Reference Dated 13.09.2024

Government of India
Ministry of Communications
Department of Telecommunications
Wireless Planning & Coordination (WPC) Wing
6th floor, Sanchar Bhawan,
20, Ashoka Road, New Delhi - 110001

No.: L-14035/10/2022-BWA

Date: 13.09.2024

To,

The Secretary
Telecom Regulatory Authority of India,
New Delhi.

भारतीय दूरसंचार विनियामक प्राधिकरण
पंजीकरण सं. 31589
17 SEP 2024
ई आफिस सं.

Subject: Clarification/ information sought by TRAI regarding DoT's reference on assignment of E&V bands; and MWA & MWB spectrum- reg.

Reference: DoT's letter dated 12-08-2022 seeking TRAI's recommendations for assignment of E&V bands; and Microwave Access (MWA) and Microwave Backbone (MWB) spectrum in existing frequency bands of 6/7/13/15/18/21 GHz bands[1].

Sir,

I am directed to refer to the TRAI's letter no| C-15/2/ (1)/2022-NSL-II dated 20-02-2024 in response to DoT letter cited under *Reference* above. TRAI, quoting the provisions of Section 4(4) and the First Schedule of the Telecommunications Act, 2023, has mentioned that DoT's reference dated 12-08-2022 may require review in respect of the item (a) and (b) of the reference i.e., methodology of allocation (auction) and requested to provide specific issues on which their recommendations would now be required.

2. While agreeing to the TRAI's observation that *Backhaul* spectrum is part of First Schedule of the Act, for which the assignment method would be administrative, it is to state that DoT's letter dated 12-08-2022 on the 6/7/13/15/18/21 GHz bands was based upon techno-regulatory state at that point of time. Meanwhile, apart from passing of the Telecommunications Act, international regulatory landscape has seen some changes at the *World Radiocommunications Conference (WRC) 2023*. The Telecom Service Providers (TSPs) have also demanded amended usage of some of these bands. Without going into the merit of these demands, these are mentioned in the developments below:

2.1 6 GHz: While the upper 6 GHz band (not part of this reference) i.e., 6.425-7.125 GHz has been identified for IMT in other parts of the world, the lower 6 GHz band i.e. 5.925 to 6.425 GHz continues to be used as backhaul.

2.2 7/13/15/18/21 GHz: The spectrum band 7.125 to 8.400 GHz (7 GHz) & 14.8-15.35 GHz (15 GHz) are being considered for IMT i.e., *Access*, under agenda items 1.7 of WRC-2027. One of commercial telecom service providers holding Unified License with Access service authorisation and providing wireline services has requested for spectrum in the 6/7/13 GHz bands for establishing links for last mile connectivity solutions in certain Licensed Service Areas.

2.3 Requirement of captive users: Point to point connectivity requirements of certain captive users is required to be met from one or more of these bands i.e. 6/7/13/15/18/21 GHz bands. Such requirements are generally localised and mostly limited to few links only. In case, some carriers are specifically earmarked for such use, they can be re-used among multiple users with geographical separation.

It may be noted that current use of 6 GHz (lower)/7/13/15/18/21 for backhaul purposes continues to be covered under the First Schedule of the Act.

3. The Developments related to V - band and E - band are described below:

3.1 The **V-band** (57-64/66 GHz)[2] is a part of the band *n263* of 3GPP (57 GHz to 71 GHz), which is also referred to as 60 *GHz band*. That is to say that the complete 57-71 GHz band has been planned by 3GPP as IMT/ Access band. Point to point (backhaul) solutions are also available in the V band. Further, a part of this band, i.e., 66-71 GHz, has already been identified by ITU globally for IMT based Access services in WRC-19.

3.2 The **E-Band** (71-76 GHz/ 81-86 GHz) has already been assigned LSA-wise for *Backhaul* purpose to TSPs on provisional basis, during 2022. One of the commercial telecom service providers, holding UL with Access service authorisation, has sought permission for using this band for *Access Services*, in addition to the *Backhaul* purposes. i.e. as *IAB* (*Integrated Access & Backhaul*). In addition, another service provider, holding UL with Internet service authorisation (ISP) has sought E/V band spectrum for last mile connectivity purpose.

4. In view of above, TRAI, considering the relevant clauses of section 4 of the Telecommunications Act, 2023, is requested to provide its recommendations under section 11(1) (a) of the TRAI Act on the following:

(a) Demand assessment and scope of service/usage for (i) 57-64/66 GHz (V-band) and (ii) 71-76 GHz/ 81-86 GHz (E-band) and accordingly methodology of assignment of spectrum and associated terms & conditions, in line with the determination of scope of services/ usages by TRAI i.e. "Access" or "Backhaul" or "Integrated Access & Backhaul (IAB)".

(b) Spectrum charges and related terms & conditions such as spectrum cap, carrier aggregation, etc. for assignment of spectrum in 6 (lower)/7/15/13/18/21 GHz bands for backhaul purposes of commercial telecom services.

(c) Any need for review in respect of use of 7/15 GHz bands in view of consideration of these bands for Access using IMT after WRC – 2027.

(d) Quantum/ band(s) of spectrum to be earmarked for last mile connectivity (Fixed Wireless Access) of commercial telecom services and methodology of assignment of spectrum and associated terms & conditions in non-IMT bands as referred to in Para 2.2 above.

(e) Quantum/ band(s) of spectrum to be earmarked for Backhaul purposes for non-commercial/captive use and associated terms & conditions including charges as referred to in Para 2.3 above.

(f) Feasibility & technical parameters, for allowing low power, indoor, consumer device- to-consumer device usage on license-exempt basis in V-band as referred to in Para 4(d) of reference dated 12-08-2022.

(g) Provide any other recommendations deemed fit for the purposes mentioned under (a) to (f) above.

This issues with the approval of Competent Authority.

(M. Revathi)
Joint Wireless Adviser
to the Government of India
Email: m.revathi@nic.in
Phone: 011 2303 6534

[1] The exact frequency ranges of 6/7/13/15/18/21 GHz MWA/MWB bands are 5.925-6.425 GHz, 7.125-7.725 GHz, 12.75-13.25 GHz, 14.5-15.5 GHz, 17.7-19.7 GHz and 21.2-23.6 GHz respectively.

[2] The V band is generally referred to be as 57-64 GHz. The extended V band is considered to be from 57 to 66 GHz range.

Annexure-2.1: Details of the frequency carriers in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz 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 3.1: DoT's Guidelines dated 25.07.2022 for allotment of E-band carriers to Access Service Providers

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

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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

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Date: 2022.07.25 19:49:40 +05'30'

(Avneesh Kumar)
Assistant Wireless Advisor 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

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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 frequenc 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-14025/200(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 order dated 11.12.2023

Part-I (Royalty Charges)

1. Annual royalty Charges for radio stations in Fixed Services and Mobile services having multiplexed multi-channels for Captive use will be multiplication of the M-factor (Basic Royalty), C-factor (No. of frequency carriers) and W-factor (Bandwidth).

Royalty (R) = MxCxW

Table-1: Rate of M-Factor

Distance Category	Maximum Distance (Km)	Value of M Factor
I	<= 2	750
II	> 2= 5	1500
III	> 5 <= 25	3000
IV	> 25 <=60	6000
V	> 60 <=120	11000
VI	> 120 <=500	18750
VII	> 500	25000

Table-2: Rate of bandwidth factor

Slabs of Adjacent Channel Separation (BW), in MHz	Value of W factor
More than 375 kHz and including 2 MHz	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
More than 28 but <= 56	150
More than 56 but <= 112	180
More than 112 but <= 256	210
More than 256 but <= 512	240
> 512	240+ 30 x (Excess bandwidth / 256) *

Annexure-4.4: International Experience related to spectrum charging/pricing of Microwave Bands (6/7/13/15/18/21 GHz)

Sr. No.	Country/Regulator	Spectrum Charges/price
1	Office of the Communications Authority (OFCA) - Hong Kong	Band auctioned- 6/7 GHz(6570-7025 MHz) for mobile services. The Minimum Fee(reserve price)-HK$40 million.[135] Per 20MHz block equivalent to HK$ 2 million per MHz Total spectrum Sold -300 MHz Total proceeds from auction – HK$630 million Auction determined price per MHz – HK$ 2.1 million[136]

[135] https://www.ofca.gov.hk/filemanager/ofca/en/content_1713/6_7_ghz_band_auction_IM.pdf
[136] https://www.info.gov.hk/gia/general/202411/29/P2024112900425.htm

Annexure-4.5: International Experience related to spectrum charging/pricing of E Band

Sr. No.	Country/Regulator	Spectrum Charges
1	Australian Communications and Media Authority, Australia	Light License structure with License Fee of US$ 122.78 per year for E-band. [137]
2	Commission for Communications Regulation, Ireland	Traditional PTP License structure with License fee of US$ 1056 per year for E-band. [138]
3	Federal Communications Commission (FCC) - USA	Online Light License structure with License fee of US$ 75 for 10 years for E-band. [139]
4	Roskomnadzor, Russia	Light license structure with minimal registration fee for E-band. [140]

[137] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf
[138] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf
[139] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf
[140] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

5	Telecommunications and Digital Government Regulatory Authority (TDRA) - UAE	Traditional PTP License structure with License fee of US$ 1225 per year for E-band. [141]
6	Telecommunications Regulatory Authority, Kingdom of Bahrain	Traditional PTP License structure with License fee of 1% of generated revenue for E-band. [142]
7	The Telecommunications Regulatory Commission (TRC), Jordan	Traditional PTP License structure with License fee of US$ 282.09 per year for E-band. [143]

[141] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf
[142] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf
[143] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

List of Acronyms

3GPP	3rd Generation Partnership Project
5G	Fifth Generation
ACMA	Australian Communications and Media Authority
ADP	Auction Determined Prices
AFC	Automated Frequency Coordination
AGR	Adjusted Gross Revenue
AI	Agenda Item
CCIR	International Radio Consultative Committee
CDMA	Code Division Multiple Access
CEPT	European Conference of Postal and Telecommunications Administrations
dB	Decibel
dBi	Decibels relative to Isotropic
DoT	Department of Telecommunications
DSNG	Digital Satellite News Gathering
EESS	Earth-Exploration Satellite Service
EHF	Extremely High Frequency
EIRP	Effective Isotropic Radiated Power
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FDD	Frequency Division Duplexing

FDS	Field Disturbance Sensor
FBO	Facilities Based Operator
FSS	Fixed Satellite Service
FWA	Fixed Wireless Access
FR	Frequency Range
FY	Financial Year
GHz	Giga Hertz
Gbps	Gigabits per second
GSMA	Global System for Mobile Communications Association
GURL-FRLD	General User Radio Licence for Fixed Radio Link Devices
HF	High Frequency
HITS	Headend In The Sky
IAB	Integrated Access Backhaul
IMDA	Infocomm Media Development Authority
IMT	International Mobile Telecommunications
IoT	Internet of Things
IEEE	Institute of Electrical and Electronics Engineers
ISP	Internet Service Provider
ITU	International Telecommunication Union
ITU-R	ITU - Radiocommunication
LF	Low Frequency
LIPD	Low Interference Potential Devices
LPI	Low Power Indoor

LSA	Licensed Service Area
MF	Medium Frequency
KHz	Kilo Hertz
KM	Kilometer
MGWS	Multiple Gigabit Wireless System
MHz	Mega Hertz
MIMO	Multiple Input Multiple Output
mmWave	Millimeter Wave
M2M	Machine to Machine
MW	Microwave
MWA	Microwave Access
MWB	Microwave Backbone
NFAP	National Frequency Allocation Plan
NLD	National Long Distance
NLOS	Non Line of Sight
NPV	Net Present Value
NR	New Radio
OFC	Optical Fiber Cable
OEM	Original Equipment Manufacturer
PTP	Point to Point
PSU	Public Sector Undertaking
RoW	Right of Way
RLAN	Radio Local Area Networks

SBO	Services Based Operator
SHF	Super High Frequency
SUC	Spectrum Usage Charge
SRD	Short Range Device
TDD	Time Division Duplexing
TRAI	Telecom Regulatory Authority of India
TSP	Telecom Service Provider
UHF	Ultra High Frequency
UL	Unified License
UMC	Universal and Meaningful Connectivity
UNICEF	United Nations International Children's Emergency Fund
VSAT	Very Small Aperture Terminal
VHF	Very High Frequency
VLF	Very Low Frequency
VLP	Very Low Power
WLAN	Wireless Local Area Network
WPAN	Wireless Personal Area Network
WPC	Wireless Planning & Coordination
WRC	World Radiocommunication Conference
WAS	Wireless Access System